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March 24, 1932

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Engineering News-Record

Railroad Construction—Despite depression a number of notable railroad construction jobs have been steadily pushed ahead. This issue in which the meeting of the American Railway Engineering Association is reported also presents several of these typical 1931 projects:

Building the Great Northern, Western Pacific Link
Santa Fe's New Canadian River Bridge in Texas
Railway Improvements in Oklahoma City

Also: All-Metal Office Building . . . . A Remedy for the Public Roads Crisis . . . . New Record Span Welded Bridge . . . . Grouting Long Railway River Tunnel

Western Pacific Construction
in Northern California

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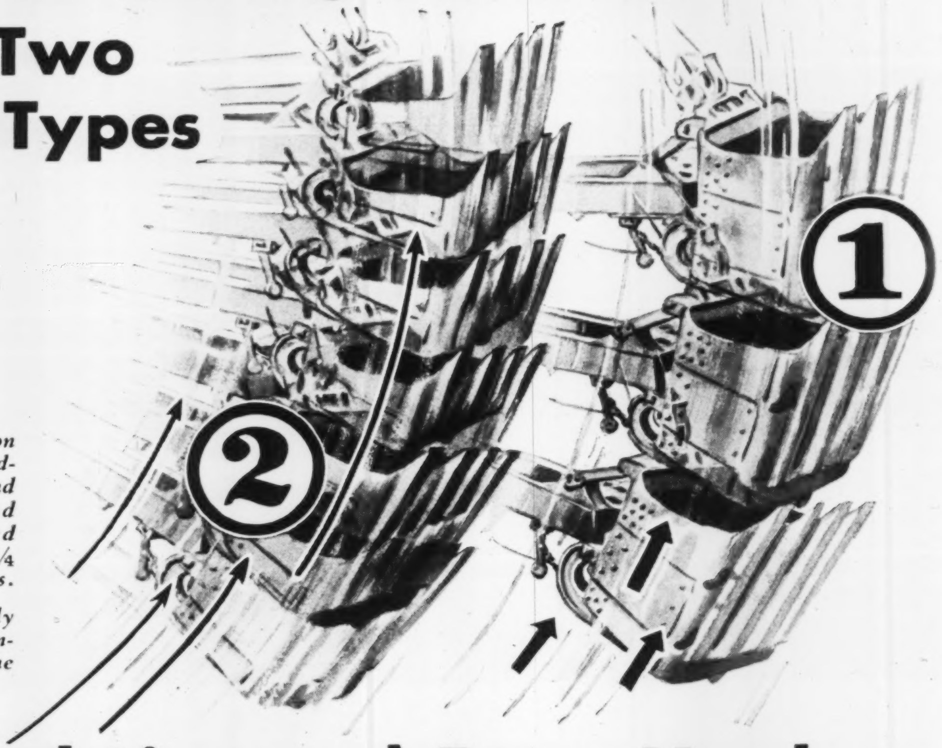

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F. E. Schmitt, Editor

Volume 108 New York, March 24, 1932 Number 12

Leading Articles

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Better Outlook for Cities

INCREASING activity in the municipal bond market makes the outlook for city construction operations distinctly better than it has been so far this year. Experts forecast further improvement, and it is therefore possible that a large part of the work recently shut down or deferred may after all be carried out this year. Some high financial authorities go so far as to predict that in a short time bond buyers will be competing actively for municipal securities. Present bidding is still far from that condition, but the improvement of the past two weeks, credited to the stabilizing effect of the Reconstruction Finance Corporation and the Glass-Steagall Act, gives much promise. By providing employment, maintained public-improvement activities will be helpful to the revival of industry and trade, though up to the present time these have shown little effect of the credit mobilization which the measures provide. The strengthened purchasing power supplied by new construction, if not too long delayed, will unquestionably serve as a most essential stimulator.

Welding Here and Abroad

COINCIDENT with the remarkable growth in the utilization of structural welding in this country, European engineers have steadily been adding to the number and type of their welded structures. While a detailed quantitative comparison of accomplishment is not available, it is apparent that American engineers have made the most rapid strides in applying welding to tall buildings. On the other hand, European engineers can point to more all-welded bridges of substantial size. Of the four longest welded truss bridges in existence three are in Europe. The single American bridge, that at Chicopee Falls, Mass., is a railway structure and is thus heavier than the European bridges, which are for highway service. Until recently the Chicopee Falls bridge could also boast the longest span, but the new Czechoslovakian bridge described in this issue exceeds it materially. Although most of the all-welded bridges are in Europe, it is worth recording that American railroad engineers have been particularly active in utilizing welding for the repair or reinforcement of bridges, a recent compilation giving 75 existing bridges in which welding has been utilized to a major degree in repair and alteration work; highway engineers have been slower in adopting welding as a useful tool. While no European research can be said to approach either in magnitude or scope the work of the structural steel welding committee in this country, it is clear that structural welding is advancing in acceptance in all parts of Europe as well as in America.

Previewing Engineering

AN EXPERIMENT in professional or vocational guidance is to be made this summer by Stevens Institute of Technology, where a group of preparatory school boys is to be assembled at the Institute's summer camp in the New Jersey hills for a period of field work, lectures and play. Field work will consist of simple surveying. The lectures, by leaders of thought in engineering and its closely allied industries and by students of applied psychology, will be directed toward giving the boys a broader picture of the realities of engineering than they now possess. One purpose is to divert away from engineering study those boys whose natural aptitudes appear best suited to a liberal arts course in college. This objective, as well as the more general one of helping the boy to choose his course in life, is much to be desired. As President Davis of Stevens states in his announcement, similar schools might well be set up for boys intending to enter other professions. Today too many enter a particular course in college only to find, after having wasted time and money, that it goes contrary to their natural abilities, or that their lasting satisfaction lies in another direction of work.

Real Service

THOSE who buy construction service have a primary stake in the reputation, ability and past performance of the contractor to whom a contract is to be awarded. For their use a list of some 5,000 contractors has just been published by the Bureau of Contract Information, as an index to full information about the performance record of these contractors. The bureau makes these records available without cost to architects, engineers and officials charged with awarding of contracts. It is thereby providing a service of unquestionable value in helping the construction buyer to determine in advance the integrity of his contractors. Prequalification or postqualification, or dependence upon license laws, cannot compare in effectiveness with a verified record of performance and credit standing. While the published list includes only contractors who have voluntarily filed their performance records, the bureau has information on many more whose records have been determined by special investigation upon request. Further, reports on construction firms include reference to officials who have been concerned in contract failures or defaults in previous connections. In all, the Bureau of Contract Information is offering a service that if fully used will advance the interests of public authorities and all other buyers of construction, and will progressively raise the quality of the contracting industry.

Leadership Wanted

IT IS not surprising that the backers of the proposed California constitutional amendment to allow initiation of a state water development plan have made slow progress. It is no easy matter to draw up a measure for a great and involved program which will have to surmount the hurdle of the legislature and the voters, then run the gantlet of constitutionality, survive the inevitable struggle with holders of senior water rights backed by past court decisions, and, finally, prove acceptable after minute inspection by financiers. Among the major problems of the work are: (1) the provision to be made to secure the support of the holders of adjudicated water rights, and (2) how to place the cost burden on those most directly benefited, the agricultural interests, though they are least able to pay. These are far greater than the technical problems that deal with acre-feet of water available. Yet the undertaking is still fundamentally an engineering development. The people of the state have a right to look to the engineers for leadership in such thinking.

One in Forty Million

THE first fatal accident in the Holland Tunnel, coming after four years of operation and the safe passage of 48 million vehicles, serves to emphasize the inherent safety of the traffic-control system in the tubes and the efficiency of the policing system. It would be inaccurate to say that the accident occurred in spite of the elaborate control system, for it was caused by direct violation of two of its essential elements. A driver traveling in the high-speed lane on the westbound tube cut across into the slow lane, spurted at high speed to pass the car ahead, and in this attempt ran into the rear of a truck he overtook in the slow lane. The act was one of pure recklessness. Traffic through the tunnels during peak load periods is dense, and must move fast if the tunnels are to be used to greatest advantage. For this reason one of the duties placed upon the tunnel police is that of speeding up the slow driver—beyond the posted limit of 30 miles per hour, if possible; but, in the tunnel quite as much as on the open road, fast driving does not call for reckless driving. The absence of fatal accidents during four years proves that most men will observe rules of obvious necessity. Yet it is regrettable that even one reckless man in more than 40 million passengers should spoil the record so far established.

A Great Bridge Completed

THE spotlight of fame in the bridge-building world was swung half-way around the globe from New York City to Sydney, Australia, last Saturday, when the great Sydney Harbor steel arch was opened to traffic. Just as the Hudson River bridge pushed backward the borders of the impossible in suspension bridge construction, so the bridge over Sydney Harbor extends mightily the field of the steel arch. In length it lacks twenty-five inches of equaling the 1,652-ft. span of the Kill van Kull arch, but in almost every other particular—weight, traffic capacity, height, member cross-section—it reigns supreme. The history of the Sydney Harbor arch is one of the epics of the engineering art. Years in which dreams, hopes and frustrated plans followed in unceasing succession finally brought, in 1922, a worldwide competition which led to selection of an arch design nearly 700 ft. longer than the longest existing arch. The rare courage of the Australian authorities as well as that of the English designers helped to shape the decision several years later to use an arch for the Kill van Kull crossing in New York. Other contributions of the Sydney work also merit acknowledgment: the pleasing appearance of the arch outline, reminiscent of Lindenthal's Hell Gate bridge; the bold erection scheme, which made use of an elaborate system of adjustable cable tiebacks; the ingenious electric traveler derricks; and in general the initiative of the contractor displayed in many ways, not the least of which was the establishment of a complete fabricating shop on the site, thousands of miles from the home office. Notable in many ways as an engineering achievement and a great public utility the Sydney Harbor bridge also brings to view once again the unity of interest that characterizes the worldwide activities of the civil engineer.

An Engineering Responsibility

A STATEMENT published in this issue by Thomas H. MacDonald, chief of the United States Bureau of Public Roads, charges American engineering with the definite responsibility of meeting a crisis in public-roads administration. The evidence of necessity for action presented by Mr. MacDonald may be summarized in the assertion that, while states have shown the capacity to manage their public-roads affairs, counties and townships have generally failed in this duty. Exception is fairly made of metropolitan counties, many of which have well-managed road systems, but outside of these the average of county financing and technical direction throughout the nation is low, and township management generally is a failure.

The remedy, says Mr. MacDonald, is to be found in the rural states absorbing all highways into the state system, and the metropolitan states making the county the smallest unit of public-roads administration. This is perhaps the most positive statement that has come from high official authority in support of centralization as an immediate task in systematizing highway administration. It is an expression of policy which is certain to arouse opposition. But in the main the opposition is bound to be academic; the fact is that public-roads management is actually in process of centralization, forced by a demand for local road improvement and an opposing inability to increase local taxes.

Centralization of public-roads administration is already in progress, in other words. At the moment attention is centered on isolated manifestations of this movement, furnished by North Carolina last year and in the last month by Virginia. The bold action of these states in taking at one stroke all roads under state control is, however, merely the spectacular crest of a wave of opinion and action which is more strongly indicated by the steadily increasing infiltration of state influence and control into county road administration and of county influence and control into township road administration. In some cases by financial aid and the inevitably associated supervision, in other cases by gradual absorption of mileage, states and counties are centralizing public-roads management to an extent which is much more significant of the general trend than is the special action of North Carolina and Virginia.

With cooperation and consolidation a fact in the making, the task of engineering is to direct legislative thinking to correct conclusions and action, as Mr. MacDonald emphasizes. The problems of the incidence of taxation and of the distribution and control of tax money and the directly related questions of design and construction call for statesmanship having the technical background of engineering experience.

Public Engineering Efficiency

SERIOUS charges now widely current against municipal expenditure are to the effect that costs are extravagantly high, that exorbitant taxes are rendered necessary, and that these evils come to pass largely because municipal administration is inefficient, wasteful and dishonest. Too often no attempt is made to separate the sheep from the goats in bringing these charges, but all municipal officials and employees and the public services they administer are grouped together and indicted. The publisher of the Chicago *Tribune* has even gone so far as to say that anyone's employment by a governmental agency is sufficient proof of his irresponsibility!

In the face of such intemperate statements it is unnecessary to enter into discussion of the relative merits of commercial competition and professional ambitions as incentives to efficiency and economy in administration. But the grave injustice of the charges cannot be ignored, especially as they apply to the technical and professional staffs in public service. It is safe to say that public-improvement construction by and large is directed as carefully and efficiently toward the goal of social service as are the operations of most commercial enterprises toward private profit.

The engineer who plans public improvements must, it is true, compromise with his own best judgment at times because of the pressure applied by minority groups to bring about a result more in keeping with their own immediate interests. Examples are numerous where improvements have been forced into execution over the strong opposition of the city's engineers. Yet, despite such handicaps, the broad fact is that sewerage systems, water systems and highways serve admirably the purposes for which they were intended. Even in Chicago, which today enjoys such a doubtful reputation for administrative integrity, the engineering forces responsible for the planning of public improvements are accorded an enviable position by their own profession.

Municipal engineers, indeed, lead the way in many elements of sound and honest method. They are foremost in utilizing open competitive bidding and strict inspection of materials and construction. The standard set is that of obtaining the best results possible at the least cost to the city, regardless of the name or business connections of the bidder. Showing partiality to a company interested in supplying services or products at monopoly prices, a device not at all unusual in private business, becomes justly a matter of public scandal and criminal action whenever brought to light in municipal administration. The legal restrictions imposed on the conduct of public business make it evident that we most frequently demand of it a far higher standard of economy and honesty than we do of private commercial enterprise.

The operations of municipal facilities are continually a matter of public concern. Their object in every case is not to produce a money profit but to supply the best service possible with the funds available. And today's spectacle of public servants continuing to serve their citizens at no pay at all, enduring hardship and even want to prevent the deplorable consequences of governmental breakdown that would follow their refusal to serve further, stands as a model of loyalty to public trust that many private businesses might well envy.

We welcome the opportunity to speak for the thousands of efficient and capable engineers in public service now under fire. Their day in court has not yet come. But the indictments against them are being brought in most cases by men whose reputation for ability to meet their social responsibilities by efficient and honest administration of private business has been much tarnished within the past two years.

The Emergency Road Appropriation

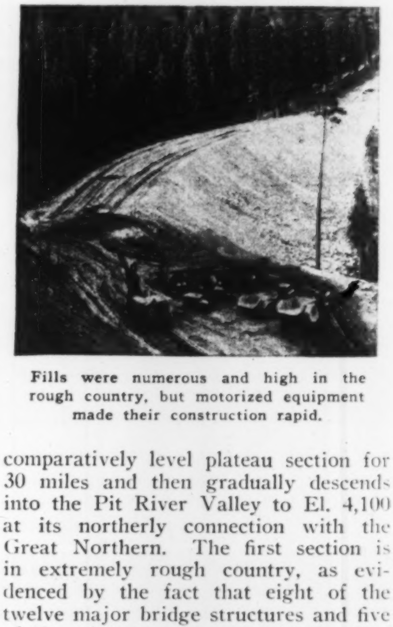
ENACTMENT of the bill providing an emergency loan of $120,000,000 for state highway construction will decide whether 1932 is to be a moderately normal year in highway construction or one recording a decided slump in this important activity and setting a new low point in public-works depression. Prompt action by the House of Representatives in approving the appropriations has been followed by delay in the Senate, caused chiefly by contention over the method of spreading the money. This, it is urged by strong opinion, should be according to population and so, supposedly, according to the numbers of unemployed, instead of by the method of allotment provided for regular federal-aid highway funds. In the background, assuming favorable action by the Senate, there finally remains the threat of veto indicated in the criticism of the House action by the Secretary of Agriculture. So much for the facts of legislative progress.

Argument for the appropriation is that it is a loan which will be repaid to the federal treasury, that the loan will be invested in revenue-paying improvements and that beyond most construction operations the money will go into the hands of labor—about ninety cents of every dollar. No one in or out of Congress has offered evidence that successfully controverts any part of the argument. Here, then, we have a situation in which the right course of action is plainly so snarled and tangled by "political" reasoning that a positive unemployment relief measure is endangered and a great transportation development program is threatened with a setback. The roadbuilding industry has a definite task of whipping sound sense into its legislators at Washington.

New Pacific Coast Rail Line Formed by 203-Mile Link

Northwestern states get a new outlet to California and the Southwest through the construction of 203 miles of railway line by the Western Pacific and Great Northern—Heaviest construction largely concentrated in 112-mile line built by the Western Pacific

Nine tunnels on the line aggregated 5,338 ft. Portals were either concrete or timber with placed rock as shown.



Fills were numerous and high in the rough country, but motorized equipment made their construction rapid.

THE NEW railway route between California and the north Pacific states, brought into service by the completion last fall of a 203-mile link between Klamath Falls, Ore., and Keddie, Calif., is the accomplishment of a project conceived and started simultaneously by rival interests some 23 years ago, which was halted in mid-career by financial difficulties and then abandoned on account of World War conditions. Both the Great Northern and the Union Pacific had proposed to build south from their parallel main lines along the Columbia River to reach the higher interior tableland of Oregon and thence to push on down into California, forming a through north-and-south route on the east side of the coast range to compete with the Southern Pacific route on the west slope. In 1910 both the former systems were building feverishly from the Columbia River up the Des Chutes River, mainly on opposite sides, but in some places the construction work was so difficult and so heavy that the rivals built a single joint line. The Union Pacific interests stopped first, but the Great Northern pushed on as far as Bend, Ore., 150 miles, before abandoning construction. About fourteen years later the Great Northern revived the project and extended the line 65 miles to a connection with the Southern Pacific at Chemult, from which point it operates 82 miles to Klamath Falls, Ore., over Southern Pacific tracks. In 1929 the Western Pacific (extending from Ogden to San Francisco) and the Great Northern entered into a joint agreement to build a 203-mile link connecting their two systems. Most of the heavy construction involved in building that link was concentrated in the section built by the Western Pacific. This article describes chiefly that part of the work, only giving enough data concerning the Great Northern work to make the article complete. —EDITOR.

CONSTRUCTION of a 203-mile railway line in California and Oregon by the Western Pacific and the Great Northern railways stands out as one of the major construction projects of the Far West in recent years, in addition to being important as a new traffic route connecting the Pacific Northwest with central California and the states of the Southwest. The northern section of the line was built by the Great Northern as an extension of its line south into Klamath Falls, Ore., and the southern section was built by the Western Pacific as a new line north from Keddie, Calif. The two lines join at Bieber, Calif.

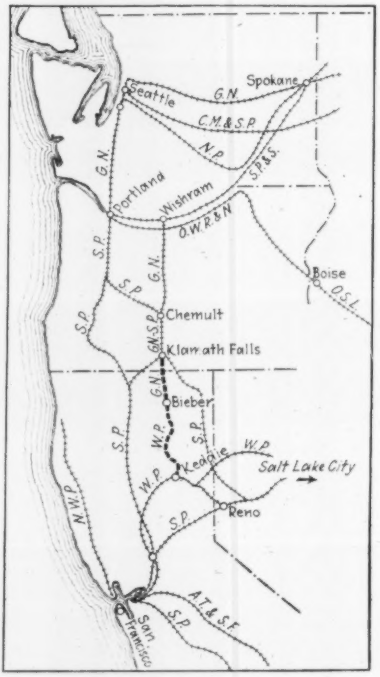
Permission of the Interstate Commerce Commission for the construction of this connection was requested Feb. 14, 1929; a hearing was held in San Francisco in November of that year and permits were granted June, 1930. The decision of the commission approved the construction because the major connection thus formed would provide a competing system in an extensive territory previously served by a single railroad line, would open up an area of standing timber tributary to the new line and would reach a section of almost undeveloped country.

Contracts for the construction of the new line were let in the summer of 1930, and the line was opened to traffic in November, 1931. Thus there is now a new through-route between California and the Northwest and Central West, 1,053 miles from Spokane to San Francisco. At San Francisco a connection with the Santa Fe system gives access to southern California and the Southwest.

Western Pacific construction

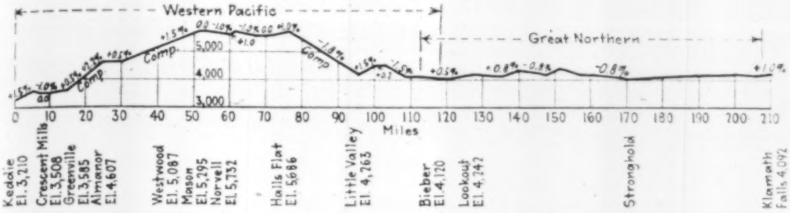
Extending northerly from Keddie along the backbone of the Sierra Nevada Range, the new line of the Western Pacific rises from El. 3,100 to a high point of 5,732 ft. in 50 miles. From that point it runs along a high, comparatively level plateau section for 30 miles and then gradually descends into the Pit River Valley to El. 4,100 at its northerly connection with the Great Northern. The first section is in extremely rough country, as evidenced by the fact that eight of the twelve major bridge structures and five of the nine tunnels occur in the first 7 miles. In this section the line crosses a series of precipitous canyons before beginning the gradual climb past Lake Almanor to the summit at Norvell. The following 30-mile section on the plateau east of Lassen Volcanic National Park is of comparatively light construction. The remaining section to the north is featured by side-hill location where benching is the predominant type of grading.

The new Great Northern-Western Pacific line gives a second outlet to the south from points in the Pacific Northwest.



In general, the terrain is rough, mountainous and typical of north central California. The territory is covered with a dense growth of yellow pine and other conifers, except for short sections at either end.

Contract Set-Up—Following an inspection of the entire Western Pacific section by a group of selected contractors, headed by the chief engineer and staff, bids were requested on the project as a whole. The low bid was submitted by a combination formed by the Utah



The steepest grades are found in the southern half of the new line where it crosses over the Sierra Nevada Range.

MILEAGE, ELEVATIONS AND THROUGH DISTANCES

		Miles	Elevation
San Francisco, Western Pacific			25
Keddie, Western Pacific		281	3,212
Norvel (summit), Western Pac.	new line	52	5,732
Bieber, meets Great Northern	new line	60	4,120
Klamath Falls, Great Northern	new line	91	4,100
Chemult (summit) Great Northern		82	4,754
Bend, Great Northern		65	3,600
Wishram (Columbia River), Great Northern		151	162

THROUGH DISTANCES BY NEW ROUTE

San Francisco to Portland	888
San Francisco to Spokane	1,053

Construction Co., Ogden, and W. A. Bechtel Co., San Francisco, known as the Utah-Bechtel Co. Award of the general contract at about $5,000,000 was made to this company. It covered major items, including clearing, grading, bridges, trestles, culverts, tunnels, track and ballasting. Rights-of-way, fencing, cattle guards and minor structures were let under separate contract. The general contractor divided the line into eight sections, retained two for its two constituent organizations and sublet the other six sections under contracts that included handling of general work, bridge foundations and retaining walls. Bridge-steel erection and tracklaying were awarded as separate contracts by the general contractor.

Clearing and Grading—About 53 per cent of the line lies within national forest areas and involved clearing of heavy timber under supervision of the U. S. Forest Service. The clearing amounted to 1,932 acres, most of it on heavily wooded slopes, and was done the latter part of 1930. Much of the timber was used during construction for temporary work, tunnel packing and at the camps. The rest of the merchantable grade was sent to the mills at Westwood.

With minor exceptions, the grading operations, which involved 4,000,000 cu.yd. of material, were done with gas and steam shovels, truck transportation being used. One exception was the level plateau section where fills were relatively low. There draglines were used. In some cases 500 lin.ft. of fill was placed with a dragline in 24 hours, using a crew of three men per shift. As a general rule, the equipment was taken to the various points of the job under its own power. Side slopes of cuts varied from ½:1 to 1:1, and slopes of fills were 1½:1.

One of the special grading features was the cut at Sheep Camp Creek, involving the removal of 256,000 yd. from a 110-ft. depth of cut and the use of this material for fill. For this work 12-yd.-capacity, tractor-drawn, two-wheel carts were used.

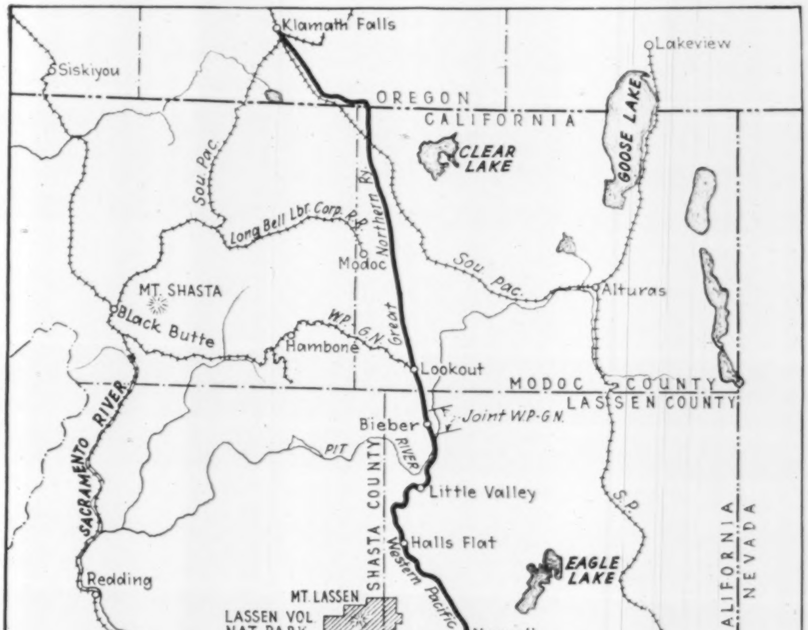
Another major feature of the excavation work was a blast of 100,000 lb. of explosive to loosen a section for rock benching. The shot loosened 175,000 tons of side-hill material along a 450-ft. section of line.

During the height of the work 27 shovels were in use on the entire project, together with their complement of compressors, drills and other equipment. About 62 per cent of the excavation work was rock.

Bridges—The schedule for bridging waterways, side draws and ravines was early recognized as having an important relation to the speed and cost of the entire project. Preliminary study showed that it would be impossible to build major structures in advance of the grading because the limited width, excessive curvature and steep grades of the available roads would prohibit the trucking in of bridge steel. As a result, the structures were designed for speedy erection as the track was completed to the successive sites. Further consideration eliminated use of structures that would require falsework, because of difficulties in handling material and the delay required to prepare for their erection.

Accordingly, all major bridge structures are of the viaduct type with maximum span lengths of 75 ft. between towers, except the initial span at Spanish Creek, where a 95-ft. span was used because of interference. The structures are all of the deck-plate girder type. Foundations were built at the

The major part of the new line is in the mountainous section of northern California.


Klamath Falls
Lakeview
Siskiyou
OREGON
CALIFORNIA
CLEAR LAKE
GOOSE LAKE
Sou. Pac.
Long Bell Lbr. Corp. R.R.
Northern Ry.
Modoc
Sou. Pac.
Alturas
MT. SHASTA
Black Butte
W.P. G.N.
Great
Hambone
Lookout
MODOC COUNTY
LASSEN COUNTY
Joint W.P.-G.N.
Bieber
PIT RIVER
SACRAMENTO RIVER
SHASTA COUNTY
Little Valley
S.P.
Halls Flat
Western Pacific
EAGLE LAKE
CALIFORNIA
NEVADA
Redding
MT. LASSEN
LASSEN VOL. NAT. PARK
Norvell
S.P.
HONEY LAKE
To Salt Lake City
Southern
Red Bluff
LAKE ALMANOR
Almanor
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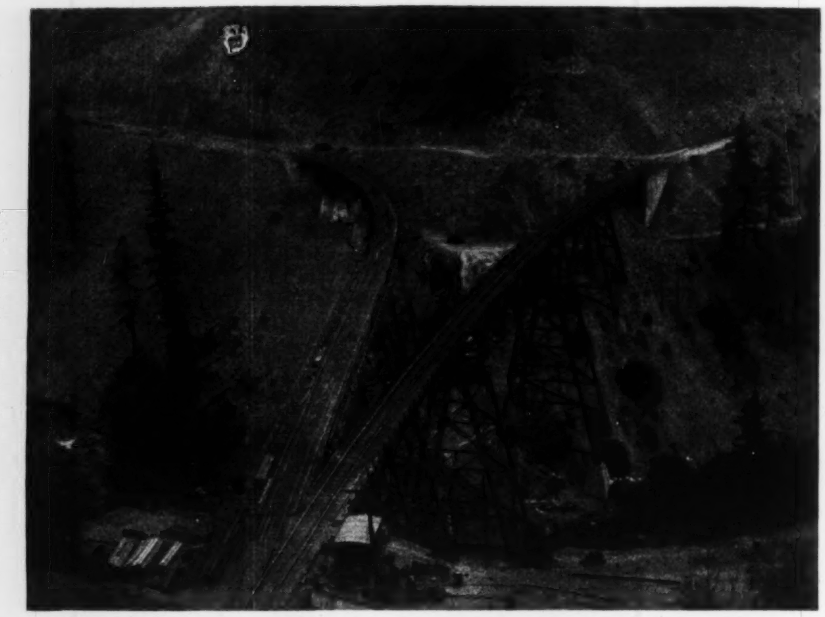


Swinging north, the extension leaves the Western Pacific main line on a viaduct 617 ft. long. The third leg of a Y connection is provided by a tunnel through the ridge in the background.

time of grading and were ready for steel erection when track work advanced to the site. Three viaducts are more than 100 ft. high, the highest being at Clear Creek. It has a maximum height of 225 ft.

One of the most important structures of the line was the Spanish Creek viaduct at the south end of the new line. It begins at a point a few feet beyond the east portal of a main-line tunnel and where the main line swings south on a 3-deg. curve across Spanish Creek on a similar viaduct. The new line leaves the main line at an angle of 5 deg., 44 min., part on tangent and part 10-deg. curve. The two legs of the Y formed by the two viaducts are connected by a tunnel on the far side of the canyon to form the third leg of the connection, and they afford a direct line into the new terminal yard at Keddie, about a mile beyond the crossing on the main line.

Construction of the second viaduct involved many problems of interference with the existing structure and its foundations, also with main-line operations. These problems were successfully handled without delay to main-line traffic, although excavations extended 54 ft. below base of rail at the west abutment of the old structure.

Tunnels—There are nine tunnels on the line, ranging from 400 to 1,000 ft. long and with an aggregate length of 5,338 ft. On tangent, tunnels have a 17-ft. horizontal and 22-ft. vertical clearance; horizontal clearance is increased to 18 ft. on curves. Most of the tunnels are provided with 12x12-in. timber sets on 18-in. to 3-ft. centers, depending on the character of the material through which they are driven. Vertical side posts were used in all tunnels without wall plates. Portals are either concrete or timber with rock facing. Partial concrete lining is used in sections of bad ground.

Five tunnels occur in the first 6 miles of the line north from Keddie. They encountered, principally, loose and broken shale, giving considerable trouble in driving. With one exception, tunnels were driven from a top center heading, enlargement being handled by short boom shovels operated by compressed air. One of the tunnels was driven through clay for 1,000 ft., and air spades were used exclusively for excavating that section.

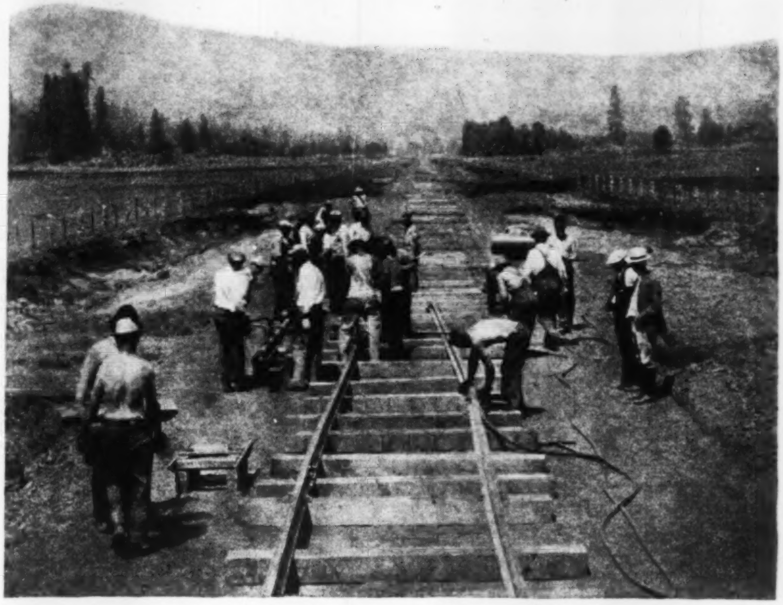
Tracklaying—Track was laid with 85-lb. rail, dinky engines and pioneer cars being used. Ties were hauled ahead of the tracklaying gangs and distributed by trucks. This advance supply was sufficient to half-tie the track. Full-tie and spike gangs followed the track laying, which averaged ¾ mile per day. All main-line track was full tie-plated and was equipped with an average of six rail anchors per rail. The line was provided with fourteen sidings in addition to the Y at the Keddie terminal.

Keddie Terminal—To handle freight traffic originating on the new line and transfers from the main line, a junction terminal yard was built at Keddie. At that point the old line is located on a steep hillside bench that had been excavated for the single main-line track. This area was widened by benching and filling to provide room for four additional tracks, totaling 33,140 ft., at the expense of moving 420,000 cu.yd. of material. In addition to the five tracks, this terminal was equipped with a four-stall timber-frame engine house with concrete pits, a 120-ft. continuous turntable, a steel-frame machine shop and boiler room, 10,000-bbl. fuel-oil storage tank and the usual water, oil and sand facilities.

The fuel-oil system provides an automatically controlled supply to the oil columns. Storage is provided in the 10,000-bbl. tank, which in turn supplies two 12,000-gal. buried tanks acting as immediate reservoirs for the oil columns. Hot oil is kept circulating from these tanks to the columns by pressure pumps, and the engine supply at the columns is controlled by limit switches.

Water supply for the terminal is obtained by a 4-in. gravity pipe line 1½ miles long from a near-by stream. The head on the line is sufficient to provide for fire protection. Storage tanks of 60,000- and 75,000-gal. capacity are

Viaducts were used for all valley crossings to permit rapid steel erection. This was desirable because lack of roads did not permit bringing in steel in advance of track construction.



The track was half-tied by truck distribution ahead of rail laying.

located in the terminal area. Full-line pressure can be delivered at the lower tank near the station for fire purposes by means of a bypass at the upper tank.

The turntable is of E-70 capacity, with concrete pit wall and circle rail foundations resting on creosoted piles. These piles are on 3-ft. centers driven to refusal. The center pier is a reinforced-concrete shaft 6 ft. square by 35 ft. deep, resting on bedrock.

Water Stations — Three principal water stations have been put in service, two having tanks supplied by deep-well turbine equipment with direct electric-motor drive and automatic float control. The third station is powered by a 40-hp. semi-diesel engine elevating water 180 ft. through a 6-in. line (6,600 ft. long) from a near-by stream. A 20-hp. semi-diesel standby unit is installed for emergency use.

The well at Hall's Flat was drilled through 700 ft. of basaltic lava to a depth of 766 ft. The lift is 646 ft. from bottom of bowls to ground line. The pump operates with a 100-hp. motor, has 21 stages, and under a 24-hour test delivered 437 g.p.m. continuously with only 1 ft. of drawdown.

Personnel—The engineering staff of the Western Pacific Railroad Co. was in charge of the project under the general direction of J. W. Williams, chief engineer. T. L. Phillips is principal assistant engineer, H. M. Smitten bridge engineer, and G. W. Frantz office engineer, located at the company headquarters in San Francisco. The field engineering force operated under direct charge of R. A. Hollenbeck, construction engineer, and E. N. Whelan, office engineer, with headquarters at Westwood.

Operations of the Utah-Bechtel Co. were under the general direction of H. J. Lawler. Subcontracts for general work on the line were let to the following: Morrison-Knudsen Co., Boise, Idaho; Paul J. Tyler, San Francisco; Lewis Construction Co., Los Angeles; Heiselt Construction Co., Ogden, Utah; Frederickson & Watson Construction Co., Oakland, Calif.; W. H. Puckett, Boise, Idaho.

A subcontract for steel erection was let to Joe Gerrick Co., San Francisco, and one for tracklaying to Worden & Forsythe, Oakland, Calif.

Great Northern construction

Concurrent with the building of the Western Pacific's extension, the Great Northern Railway extended its line south from Klamath Falls, Ore., to connect with the Western Pacific at Bieber, Calif. This line, for the most part, has easy curves and grades. The two ends are at about the same elevation, and the summit of the 91 miles of line is only 300 ft. higher than the ends. About 2,000,000 cu.yd. of grading is involved, and the structures include eight steel bridges with numerous lesser timber trestles. There are no tunnels on the line. The main track was laid with new 90-lb. rail.

The located line was accessible from existing railroads at two points. These were used for carrying forward the construction operations. Grading operations were similar in general to Western Pacific construction, with power shovels and trucks constituting the major equipment. Tractor-drawn hydraulically operated scrapers were also used for excavating and stripping.

Tracklaying was done by a machine consisting of a flat car with superstructure, which provided trams for moving rail and ties out in front of the track. Tracklaying was scheduled at the rate of 8,500 ft. of completed track per day. Bolting and spiking was done with pneumatic machines.

Terminal facilities at Klamath Falls were increased at the time of construction of the new line. At Bieber an interchange terminal was constructed jointly with the Western Pacific. This latter terminal includes about 17,500 ft. of yard track, a four-stall roundhouse, station and other buildings for employees.

Personnel—The line from Klamath Falls to Bieber was built by the A. Guthrie & Co., St. Paul, Minn., under contract that included grading, bridgework, tracklaying and surfacing. The work was carried out under the supervision of J. R. W. Davis, chief engineer, with direct supervision in charge of Col. F. Mears, assistant chief engineer, Seattle.

Half of the line lies in national forest areas and involved supervised clearing in stands of yellow pine.

Long Pontoon Forms Drawspan in Railway Bridge

Pivoted barge has elevating track deck—Timbers framed and creosoted on West Coast shipped for erection on Mississippi River by railway forces

A CREOSOTED-TIMBER pontoon 396x50 ft. for the draw opening of the Mississippi River bridge of the Chicago, Milwaukee, St. Paul & Pacific Railroad, at Wabasha, Minn. (Fig. 1), serves to call attention to this unusual type of structure, in which the fixed portions consist mainly of timber trestles, leaving a navigation channel that is closed by a single pontoon. At one end the downstream corner of the pontoon is pivoted to a pile pier, the free end resting against a pile bumper. This railway has three such bridges on the Mississippi. At the Wabasha bridge, on a short branch line to Chippewa Falls, Wis., the channel opening is 305 ft. in the clear.

The new pontoon, designed for Cooper's E-50 loading, is in reality a huge barge. It has five lines of longitudinal bulkheads built up solid with timbers 10x18 and 8x18 in., 20 to 60 ft. long, laid flat and bolted together, while circular washers or shear dowels set in the contact faces prevent any longitudinal slip. Diagonal bracing forms transverse trusses 2 ft. apart, as shown in Fig. 2. The plank sheathing on the upstream side is covered with steel plates as protection from ice. With a depth of 7 ft. 4 in. on the center line, the pontoon has a draft of 3 ft. light and about 5 ft. with a heavy train.

Elevating deck

To provide for changes in river level, there is an adjustable track deck with a vertical travel of 11 ft. (*Fig. 2*). At intervals of 12 ft. are groups of four posts seated on the bottom members of the hull and etxending about 19 ft. above the deck. The ends of I-beams, which form the floor beams of the track deck, fit between these posts. Timber stringers with ties and rails complete the track. With the river at high-water level, the floor beams rest on blocking on the deck of the pontoon. As the water falls, the track is raised by screw jacks under the floor beams, which are then supported at the required level by blocking between the posts. The changes are made in lifts of 8 in., using 8-in. blocking handled by the two attendants.

At each end of the track deck is a 41½-ft. apron, or deck girder, hinged on the pontoon, normally having its outer end seated on a pier of the approach trestle where the rails are connected by a lap joint. For operating, the pontoon has a steam hoisting engine with special sheave over which passes a chain having links 6x1¼ in. This chain is laid diagonally across the channel bed and has its ends anchored to pile clusters.

Framing and creosoting

All hull timbers are of fir and were framed, bored and match-marked before being creosoted. Lumber to be treated was sent direct from the sawmills to the treating plant at Seattle, Wash., where the Boulton process of seasoning by boiling in oil under vacuum was followed by the full-cell pressure treatment. This controlled seasoning expedited the work and resulted in less checking than is sometimes produced by air seasoning, particularly in large timbers.

Prior to treatment, all members were completely framed and bored. Where shrinkage after framing would be objectionable, the members were preseasoned by the Boulton process and, after fabrication, were creosoted under pressure. This framing of preseasoned preshrunk timber resulted in close adherence to net dimensions. All of the treated parts were incised to promote penetration of the creosote and to lessen the occurrence of seasoning checks during treatment.

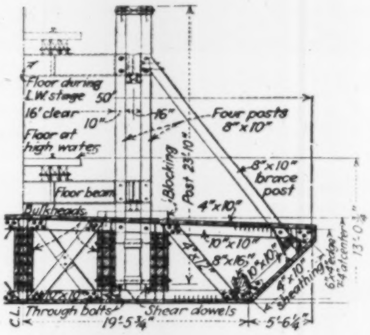


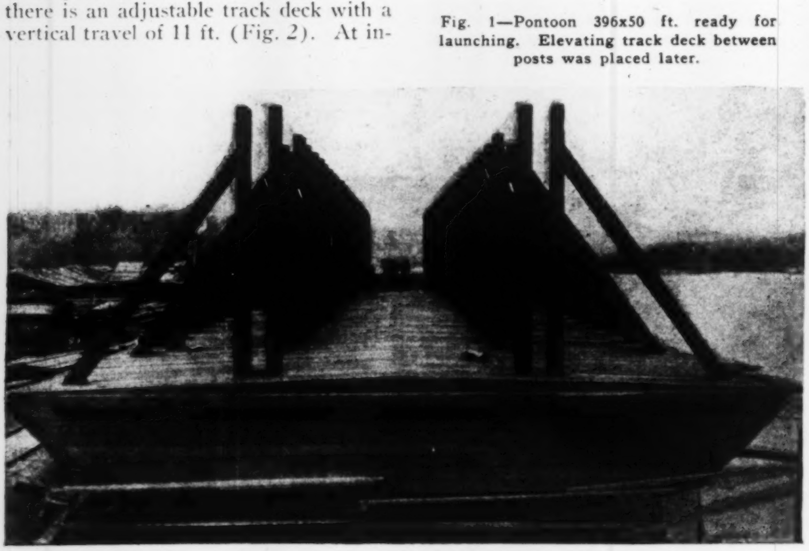
Fig. 2—Pontoon for drawspan, with track deck adjustable for water level. Note shear dowels between timbers forming solid longitudinal bulkheads.

The process was in accordance with the specifications of the American Railway Engineering Association for a 10-lb. absorption with coal-tar creosote.

Since framing at the treating plant required close accuracy, several special tools were developed, particularly for countersinking and recessing for the shear rings in the large bulkhead timbers. These ring-shaped grooves are shown in Fig. 3, which shows also the bored holes and the tooth marks of the incising machine. Bulkheads, trusses and some other parts were assembled to insure accuracy. Framing was done at a power-driven table over which were suspended multiple machines for dapping, beveling, boring and trimming, while air hoists and other handling equipment speeded the operations.

The finished material was shipped to Wabasha, Minn., where the pontoon was built on cribs on the river bank, a locomotive crane handling the timbers. When completed, it weighed about 1,600 tons and was supported by 120 screw jacks while the cribs were removed, the jacks then lowering it upon skidways with a slope of 12½ per cent. It was held by cables passed around the hull and had both ends anchored to piles on the shore side. Just above the deck a length of manila rope was spliced into

Fig. 1—Pontoon 396x50 ft. ready for launching. Elevating track deck between posts was placed later.



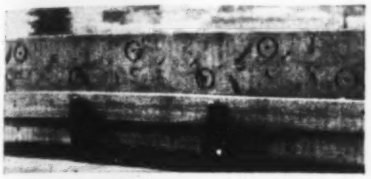


Fig. 3—Fir timber incised, bored and cut for shear rings or dowels before treatment.

each cable. On Dec. 31 the pontoon was launched, all the manila ropes being cut simultaneously and the pontoon sliding sideways into the river. It was put into service on Jan. 9, 1932.

This pontoon was designed and built under the direction of Charles F. Loweth, chief engineer of the Chicago, Milwaukee, St. Paul & Pacific Railway; W. H. Penfield was engineer of maintenance of way, Charles N. Bainbridge engineer of design, and Arthur Daniels division engineer. Framing and treating were done by the West Coast Wood Preserving Co., Seattle, Wash., and erection was by the railway's bridge and building department. Including new piling for the hinge pier and buffer pier and also the machinery equipment, the cost of this pontoon draw will be in the neighborhood of $72,000.

* * *

Chinese Railway Continues Construction Work

First section of Hangchow-Kiangshan Railway completed—Standard-gage light rails used, but structures are built for heavy loading

By Arthur M. Shaw

Consulting Engineer for Chinese National Construction Commission and Chekiang Provincial Government

In Spite of wars, bandits and political upheavals, construction of the Hangchow-Kiangshan Railway has proceeded steadily under the management of Chinese engineers, as described in this article by Mr. Shaw, who is not only consulting engineer for the national government of China and the provincial government of Chekiang, but also acts as consulting engineer for the railway. While built as a pioneer line with light track construction, it is of standard gage for connection with other lines and has its bridges built for heavy loading.

—Editor.

ONE OF THE few railway projects of China to start construction during recent years is the Hangchow-Kiangshan Railway, which is now completing its first stage to Lanchi, 201 km. (125 miles). Train service is in operation to I-Wu (76 miles), and it is expected that tracklaying will reach Lanchi this month.

Structures and Material—During the past year the rate of exchange, from silver to gold dollars, has remained at an average of about 4½ to 1. This has made it imperative that local materials be used to the fullest possible extent. In general this has resulted in more permanent construction than was originally planned, mass concrete arches being employed instead of temporary timber trestles, and concrete-pipe culverts instead of corrugated metal. As 4-ft. concrete pipes were the largest that could be conveniently handled with the equipment available, multiple lines of pipes, to as many as four lines, were used when greater capacity was required. On account of the high cost of lumber, culvert forms were of standardized design so far as practicable, so that the same forms might serve for a number of culverts. Reinforcing was used only in the 36-in. and larger sizes.

A few short-span deck girders were used, the masonry supports being prepared in advance of tracklaying and the girders brought up and placed by the track gangs. Some 20-ft. openings designed for deck-plate girders have been spanned by timber stringers, with knee-braces, as shown in Fig. 3. Where longer spans were required and it was not feasible to place the steel girders at once, intermediate concrete footings were built and temporary timber bents erected to carry wooden stringers. This proved more economical than the construction of pile trestles, because of the difficulty of transporting piledriving equipment and because rock frequently was reached at a shallow depth.

Long-continued low-river stage and other causes delayed the delivery of cement for a few of the 12- and 16-ft. arch culverts. To give the arch rings full time for setting, without delaying tracklaying, the engineer in charge of construction used empty metal cement drums as forms for concrete columns that rested on the culvert walls and were later partly embedded in the concrete of the arch rings. Timber caps and stringers on these columns carried the track until the arches were ready to receive their load. This method, illustrated in Fig. 1, saved two or more weeks' delay in tracklaying.

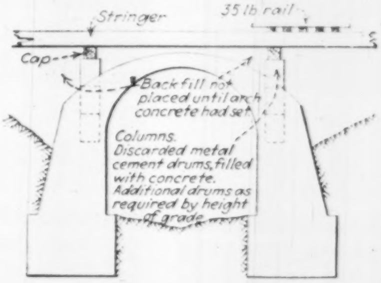
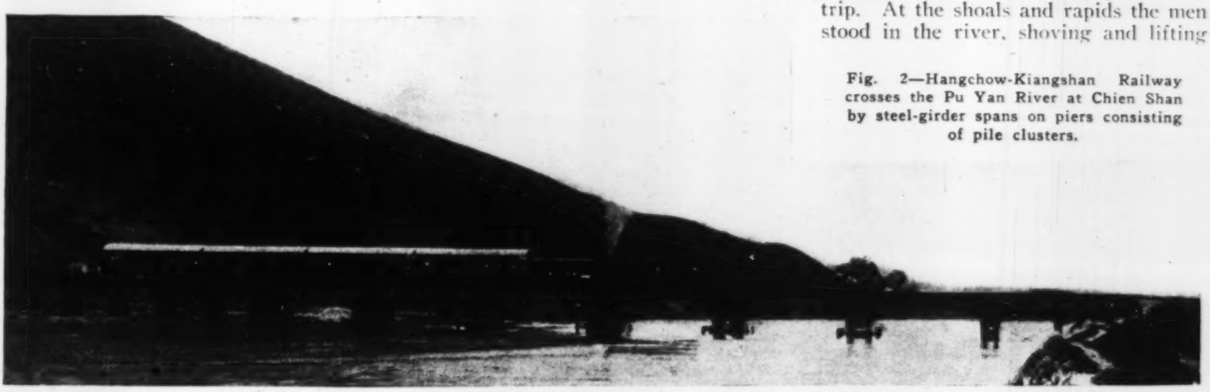

Stringer
35 lb rail
Cap
Back fill not placed until arch concrete had set.
Columns.
Discarded metal cement drums, filled with concrete.
Additional drums as required by height of grade

Fig. 1—Temporary concrete columns carry stringer spans and track over concrete culvert until arch concrete has set.

Transportation of materials in advance of tracklaying often was a major problem. Cement of local manufacture was purchased in Shanghai, brought by rail or water to Hangchow and transferred to junks for hauling up the Chien Tang River, or by canal to near-by points. In the most extreme cases the cement was taken to Lanchi (100 miles) by junks, which usually made part of the trip under sail but always required manpower for a considerable part of the trip. At the shoals and rapids the men stood in the river, shoving and lifting

Fig. 2—Hangchow-Kiangshan Railway crosses the Pu Yan River at Chien Shan by steel-girder spans on piers consisting of pile clusters.



the craft through the current, instead of pulling by tow-lines from the shore.

At Lanchi the cargo was transferred to smaller junks for transporting up the Kin Wha River as far as the stage of water would permit, beyond which it was carried on bamboo rafts. From these the cement was transferred to wheelbarrows on roads designed only for pedestrian travel. Cement purchased in Shanghai for $7.10 (Mexican) might easily cost nearly $11 on the job, but considering the conditions even this cost does not appear excessive.

Difficulties of Construction — The troubles of early lines in getting past the many graves scattered over the country are well known, and while a method has been developed that greatly simplifies this difficulty, it still is something of a problem. Walled cities also present a difficulty. In the interior there is not only a local sentiment against making a breach in the wall but the walled-in areas usually are completely filled with solid blocks of buildings, separated by narrow paved streets. In most cases the railway is located as close to the city wall as practicable, though in two cases, by agreement with the local authorities, a small breach was made at the corner. The city wall of Chuki, which dates back at least to the time of Columbus, rests on the talus of a prehistoric mountain slide. In cutting through this material to a depth of 18 ft., vitrified drain tiles, obviously in their original position, were exposed by the grading gang.

Extension to Yushan—Location surveys and detailed estimates have been completed for the second section, extending to Yushan, 230 miles from Hangchow. This will reach the headwaters of the river system of Kiangsi Province. Construction will be started as soon as the line is completed to Lanchi. Nearly the entire northern half of Kiangsi Province can be reached by boats, which navigate up to Yushan. About 70 per cent of this extension will be a valley line, but from Kiangshan to Yushan it will pass over the mountain range that forms the boundary between Chekiang and Kiangsi provinces. A low saddle affords an easy passage, with light work and little curvature.

Character of Railway—The line is designed strictly as a standard-gage "light railway," except that all permanent waterway structures are capable of carrying heavy traffic and, so far as practicable, other features are designed for a later revision to conform to Chinese Government Railway standards. The favorable nature of the country traversed has made it possible to adhere to a limit of 6 deg. (metric) for curves and grades of 1 per cent compensated for curvature. For financial reasons 35-lb. rail was used. All temporary track structures were designed to the limit imposed by this light section of rail, the axle loads assumed for designing being 7 tons for cars and 8.6 tons for locomotives. The same standards of construction will be used in the Yushan extension.

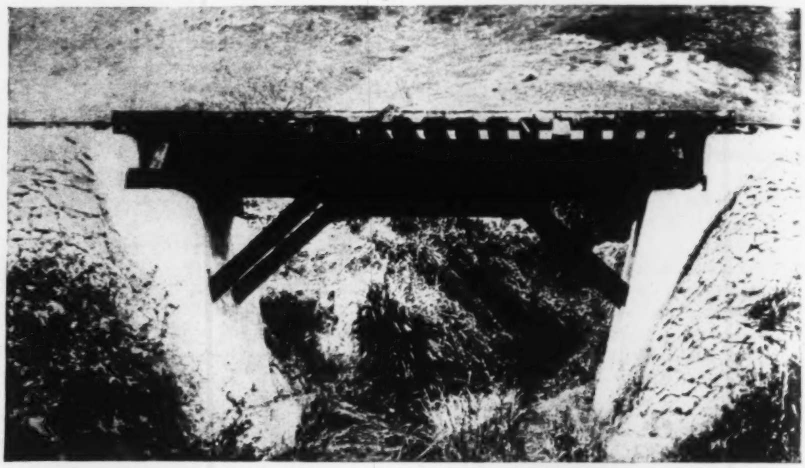
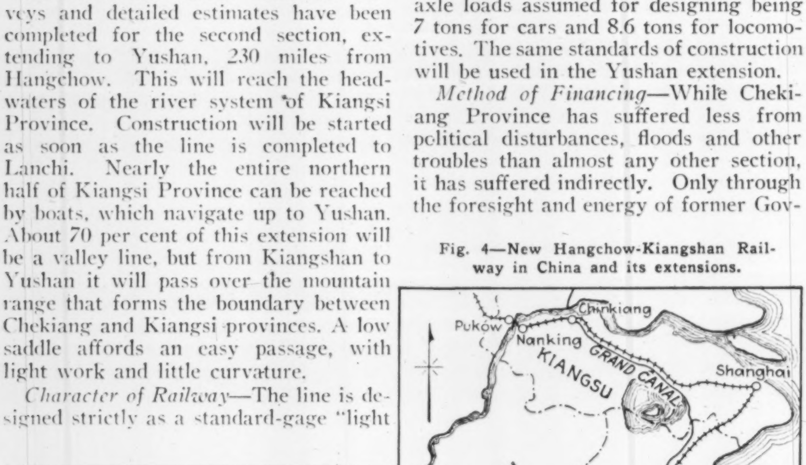


Fig. 3—Temporary 20-ft. span of timber stringers with kneebraces, on abutments built for deck girders.

Fig. 4—New Hangchow-Kiangshan Railway in China and its extensions.



Method of Financing—While Chekiang Province has suffered less from political disturbances, floods and other troubles than almost any other section, it has suffered indirectly. Only through the foresight and energy of former Governor Chang Chin-Kiang (now chairman of the National Construction Commission) has the construction of the line been made possible. As much of the provincial revenue as could be spared was devoted to the construction of this railway, and the credit of the province was pledged to local banks for the small loan found necessary for its completion.

The project is administered as a strictly provincial venture, through the construction division of the province. The commissioner of construction, Y. F. Tseng, served for three years as vice-chairman of the National Construction Commission and has undertaken to complete this railway through to Yushan during the coming year.

Operating Results—The first section, 32 km., was put in operation on June 1, 1931. Service was extended as the track was completed, thus giving an opportunity for observing the effect of additional length on the revenue derived per unit of length. Thus an average daily revenue of $1.39 (Mexican) per kilometer during the 27 days that service extended only to Chien Shan (32 km.) was followed by a steady increase to $10.19 with service to I-Wu (128 km.). As was expected, the initial revenue has been derived almost entirely from ticket sales, the development of freight business in this country necessarily running parallel with a gradual evolution of the economic changes that take place in the territory served.

Personnel—Since its inception in 1928 the project has been under the direct charge of C. Y. Tu, managing director and engineer-in-chief. Y. Y. Liu is associate director, C. Y. Hou bridge engineer, Easin Mao mechanical engineer, and M. I. Wu and Y. W. Pao are division engineers in charge of construction. The organization is 100 per cent Chinese, but the commissioner, managing director, associate director and two of the department heads are graduates of Western universities, all but one of which were American institutions. The writer has been assigned for part-time duty as consulting engineer.

A Public Roads Crisis Demands Engineering Statesmanship

Antiquated administration of local roads and piratical raids on financial foundation threaten highway development and call for vigorous intervention of organized engineering

By Thomas H. MacDonald
Chief, Bureau of Public Roads, Washington, D. C.

I DESIRE to emphasize the necessity for engineering statesmanship in planning financial and administrative policies and to assert the right, through accomplishment, of the state highway departments to formulate the principles written into future road legislation.

Ever since the first state highway department was established there has been a fairly consistent progress toward better rural highway administration. This progress can in general be credited to the engineering profession. It, however, has not been sufficiently rapid for the critical time that has now come upon us. We are confronted with a difficult fiscal situation, with the unequivocal demand for no decrease in either the quality or the extension of highway service and with an acute reaction against taxation, particularly of real property. There are more than a few demands to divert the income from special taxes upon the road user for other governmental purposes. And it is probable that in another year, although business conditions have materially changed for the better, there will be widespread and vigorous attempts to divert this income for a variety of uses and from the control of the state highway departments.

Observe the situation!

The states, without exception, that have placed the administration of the income from the gax taxes and the motor-vehicle registration fees wholly under the control of the state highway departments are in the best condition financially to carry forward their state-road programs and to extend assistance beyond the roads included within the state systems.

The states that, while not retaining within the state highway departments direct expenditure of all the income from these taxes, have provided a general control of the expenditures of the part of the income allocated to other governmental divisions are without exception able to meet their obligation for state roads, and through this definite direction they are obtaining the coordination of state and local road improvement.

The states that have divided between the states and other agencies without state control a material part of the income from these funds are almost without exception facing serious financial difficulties both on the part of the state and the localities, to maintain existing roads and to go forward with even a largely reduced program.

Local roads bankrupt

Local roads, constituting the big percentage of all public highways, have remained under the jurisdiction of the local officials, whose basic laws were provided to meet pioneer conditions, a totally different method of travel and the use of funds derived essentially from local taxation.

There are certain characteristics of this system. Among them are the multiplicity of small administrative boards with power to tax and to expend the proceeds, the election of road officials (such as that of town superintendent), the utilization of day labor or force-account methods, the lack of budgeting income or a predetermined program, the lack of engineering, the purchasing of machinery or materials in small amounts, the unnecessary duplication of equipment that cannot be used to full efficiency, road work done at the wrong periods of the year, the lack of continuous maintenance and the lack of sufficient funds to make possible efficient operation.

The county has generally been the smallest unit to have legal authority to issue bonds for rural roads. This authority, combined with bad fiscal practices, is responsible for the present inextricable financial position of many county governments. There are many counties whose assessed valuations at present would fall far below the legal requirements to support the amount of outstanding bonds.

Because of these accumulated local debts, it is difficult to determine how much can be done to relieve property taxation at once, but it is not difficult to determine that the only help for the situation that gives promise of relief is a thorough-going revision of our system of local road administration, in so far as the strictly rural townships and counties are concerned. The problem in any state must be treated with these objectives: (1) to establish an efficient organization so constituted as to withstand the spoils system; (2) to provide an allocation of available road funds so as not to defeat the greater-purpose use or to decrease income.

Administration reform

The states may be divided into: (1) those that are small in area and those in which county or town government is essentially rural in character. *In these states complete jurisdiction over the roads should be placed under the state highway departments*; (2) those states that are large in area and in which county government has been well developed and that contain a number of metropolitan areas. *In these the smaller units of government such as the townships should be consolidated under the counties, and no unit of road administration left smaller than the county.*

The metropolitan counties have sufficient road income to provide for the maintenance of an adequate engineering staff, and this should be the standard for the grouping, if necessary, of the remaining counties into districts.

An established working relationship should be set up, under which the state highway department would establish standard specifications and methods of accounting and would exercise authority to correlate local road improvements with the system of state highways.

I can see no good reason, and some disadvantages, for the large states to take over all road administration at the present time; it will be much better for the state highway departments in such states to occupy a position analogous to the position occupied by the federal government in its operations with the state highway departments.

Axioms for financing

1. All income from the gasoline tax and the motor-vehicle license fees should be placed under the control of the state highway departments.
2. The first income from these taxes should provide for all fixed obligations of the state highway system ,and a sufficient amount should be applied to a construction and reconstruction program.
3. A part of the remainder of the road income from these special taxes may be used as state aid for the secondary-road system under either the direct or general control of the state highway department.
4. The rest should be allocated to the construction and reconstruction of the streets in the cities that are a necessary part of the state highway system, under the general control of the state highway departments.

Extracts from an address delivered at the annual convention of the Association of Highway Officials of the North Atlantic States, Feb. 17-19, 1932.

In these recommendations lies the possibility of a material reduction of property taxation except where there has been an accumulation of past indebtedness so large as to absorb a large part of the income, and unfortunately this is true in some states and many counties.

Don't hazard earning power

Any reduction of the funds available to the state highway departments below that necessary for the constant improvement and extension of the state highway system will result in a loss of income from road use and a rapid depreciation of the tremendous investment already made. This is the economic brake that must be kept in efficient working order to stop raids upon these special road funds that can only result in the loss of a large part of the funds themselves.

The state highway systems must be recognized as a vast public utility whose earning capacity, if kept up to a high degree of efficiency, is very large and constantly growing but whose earning power can be cut down overnight.

Property taxation for rural road purposes cannot be replaced entirely by these special taxes. There is no state in which the income from these special taxes will support the total cost of the necessary annual road program of construction and maintenance. The principle of divisions of cost between sources of revenue based on the character of use of the roads must be recognized, which makes a distinction between those roads that are built and maintained for the general use of the public and those that are built and maintained to give access to the land.

Cooperation entirely possible

There is no insurmountable difficulty in establishing the coordinated administration necessary to produce the most effective results between the state highway department and the local units, where these are operating on a basis that justifies the maintenance of an adequate engineering force.

While the consolidation into districts of a number of rural counties that are individually unable to maintain such a force is feasible, this would be difficult to accomplish, and it would doubtless be preferable to set up for such rural counties a district under the direct jurisdiction of the state highway department, acting through district engineers appointed from its own staff.

It will be noted that the above recommendations for cooperative administration reduce in substance to a plan in which the state highway department takes over direction of all essentially rural road work, with the exception of the metropolitan counties or towns whose business justifies the maintenance of a competent engineering organization. It also extends the activity of the state highway department into the cities for the improvement of the main arteries of travel with financial and engineering cooperation between the state highway department and the city engineering departments.

This latter suggestion will be criticized, but the diversion of the income from the special road taxes to residential streets and those of new subdivisions, which will otherwise inevitably result, will not aid in meeting the cities' financial problems in providing adequate arterial roads to carry the ever-increasing concentration of traffic.

I wish to recommend to your association and to the individual states of the association that you now take the initiative in making studies along the general lines here indicated to place yourselves in the position of being able to give accurate determinative and compelling information to your state legislatures when these questions shall become acute before them. It is a time when engineering statesmanship applied in the highway field can be productive of the greatest benefits in an essential undertaking—that of providing adequate highways throughout each state.

River Tunnel in England Made Dry by Grouting

Part of long submarine tunnel through seamy and faulty strata has always given trouble—Grouting expedited by stopping railroad traffic on Sundays

IN THE $4\frac{1}{2}$-mile double-track tunnel of the Great Western Railway, under the tidal part of the Severn River in England, a length of about 1 mile has always given considerable trouble owing to seams and faults. This same section was the scene of great inrushes of gravel and water during its construction in 1879 and 1882. In 1924 and again in 1929 excessive leakage occurred due to the development of open joints in the marl above the tunnel, but in both cases the mouth of the "pipe" was accessible at low tide and it was possible to seal the opening with concrete poured from above.

Construction records and the recurring infiltration of water proved the existence of open joints and faults in the surrounding strata, and it was decided to strengthen the lining, to fill voids and stop the flow of water along the roof and consolidate the ground by the injection of cement grout. This work, which was described recently in the *Railway Engineer* by Raymond Carpmael, chief engineer of the railway, was completed in 1931.

For the first $\frac{1}{2}$-mile section a contract was let in October, 1929. Mixing and pumping apparatus and compressors for the drills were installed in sheds at the ventilation and drainage shaft near the south end of the tunnel, the air and grout pipes being led down the shaft and along the full length of the stretch to be grouted. Connections for the drill hose and for the injection branch pipes were provided at intervals. Travelers that did not encroach on the clearance limits for trains proved unsatisfactory in drilling the arch and were replaced by staging mounted on trucks running on the rails. This work was done on Sundays, the tunnel being closed for 24 hours.

Holes in the arch ring, 36 to 42 in. thick, were drilled from $3\frac{1}{2}$ to 5 ft. into the ground. These holes were of $3\frac{1}{8}$-in. diameter in the brickwork and then $1\frac{7}{8}$ in. The $1\frac{1}{2}$-in. grout pipes extended only through the lining, the large holes being well calked or packed for their full depth to prevent possible damage due to pressure before the ground was consolidated. Holes in the invert were drilled during the week, when railroad traffic was maintained. The holes extended 4 to 6 ft. below the lowest level of the lining.

Grouting was commenced at the invert and continued up the sides, ending with the holes in the crown of the arch. Considerable water was tapped, and the pressure varied according to the static head of water, with a maximum of 100 lb. injection pressure. The grout ranged from 112 to 896 lb. of cement to 80 gal. of water, for high and low pressures, respectively.

This work, completed in April, 1930, was so successful that it was decided to extend it for another half mile, or from the Bristol (south) portal until the gravel gave place to solid rock. Here the construction operation was much the same as in the first section, with some modifications suggested by experience. The two ventilating shafts were grouted in the same way, the one at the north end developing extensive voids, through which the grout traveled for an extreme distance of one-half mile, appearing then through the tunnel lining.

All this work, completed in May, 1931, was done by the Francois Cementation Co. For the tunnel there were 4,233 holes, aggregating 21,683 ft., with 8,132 tons of grout, or 148 tons per foot of tunnel. For the two shafts the 102 holes aggregated 445 ft. and took 546 tons of grout.

Intake Vortex Eliminated by Novel Screen Design

Horizontal cylindrical screen overcomes low-water problems of intake swirls, entrapped air and resulting loss in conduit capacity

By T. W. Espy
*Engineer of Water Production,
San Francisco Water Department*

THE PROBLEM of vortex formation at the inlet screen of a reservoir outlet, with resulting hydraulic losses, was overcome by a novel type of screen installed last fall at the Crystal Springs reservoir of the San Francisco water department. The principal features of the improved design are the placing of cylindrical screens in a horizontal instead of a vertical position, the increasing of the area of screened openings to five times that of the mouth of the inlet and the provision for placing a system of guide vanes over the top of the screens.

The old outlet, consisting of a shaft and tunnels with three screened inlets at different elevations, is located near the north abutment of the old Crystal Springs dam, the well-known structure that withstood the San Francisco earthquake of 1906 (*ENR*, May 8, 1930, p. 766). A second outlet of the same general type was constructed in 1931 because the extremely low stage of the reservoir made construction particularly economical, even though the additional outlet capacity would not be required for several years. The low stage also made it necessary to replace the lowest of the three screens on the old outlet, which was missing, presumably shaken off and lost in 1906.

A screen of the new design was installed to replace the missing one and was found to function most satisfactorily. There was no tendency for a vortex to form even when the water was drawn down to the top of the screen. As the water lowered, vanes, consisting of a framework of steel plates, were set over the upper half of the screen resting on angles provided along the sides, as an additional precaution against any tendency for circular motion to start. The plates were set in a vertical position; one 10-ft. plate was placed parallel to the longitudinal axis of the screen, and two 5-ft. plates were placed crosswise at the third points of the 10-ft. plate. The top of the plates extended 3 ft. above the top of the screen and, in effect, required the water to enter the screen through six compartments.

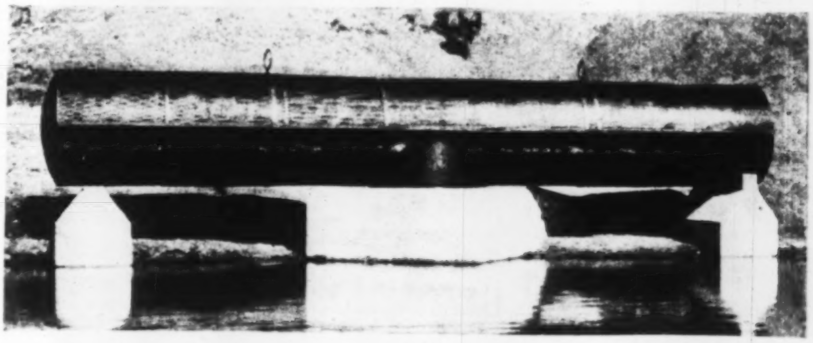


Fig. 2—New screen designed to eliminate vortex troubles in position. Cylinder is 6½ ft. in diameter by 44 ft. long. Rings are for removing screen, which is not fastened, and angle iron is to support system of steel vanes if required to reduce further tendency for vortex to form.

The screens previously in use on the old outlet were perforated cylinders 6 ft. in diameter by 12 ft. high but were placed in a vertical instead of a horizontal position over the vertical inlets to the tunnels. They had not proved satisfactory when operating conditions required use under a head of less than 8 ft. At such times a vortex would form over the inlet, becoming more and more pronounced as the water surface approached the screen, and would cause an increase in the quantity of entrapped air, seriously decreasing the capacity of the pipes and pumps below the outlet.

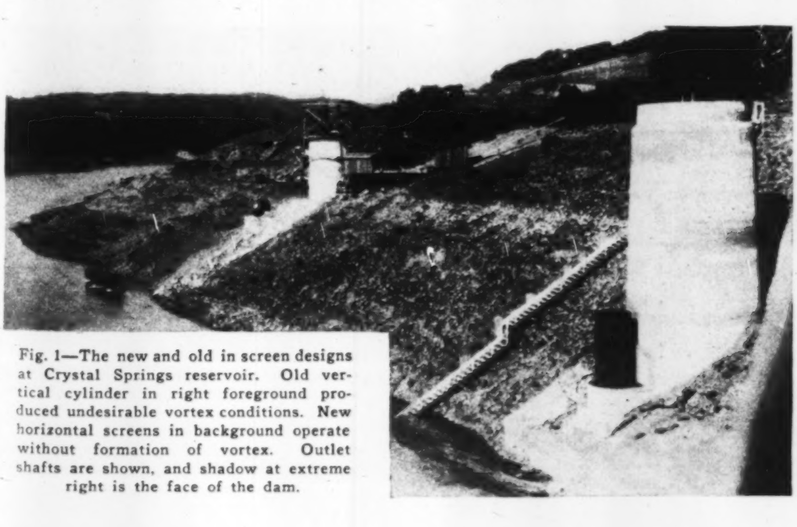


Fig. 1—The new and old in screen designs at Crystal Springs reservoir. Old vertical cylinder in right foreground produced undesirable vortex conditions. New horizontal screens in background operate without formation of vortex. Outlet shafts are shown, and shadow at extreme right is the face of the dam.

The screens placed on the new outlet (Fig. 2) are 6½ ft. in diameter by 44 ft. long with slightly convex ends, and are provided with a T-connection at the center of the lower side in the form of a metal sleeve 6½ ft. in diameter, which projects 2 ft. into the circular mouth of the inlet. An angle welded around the sleeve near the screen rests upon a bronze ring circling the mouth of the inlet. Angles welded along the middle of the sides of the screen provide support for the vanes if, in the future, they are considered desirable.

Foundations consist of a central concrete pier containing the inlet and concrete cradles to support the ends of the screen. The screens are not fastened down and are provided with rings on the top so that they can be lifted off and replaced by covers to seal the inlets in case it becomes necessary to unwater the tunnels or shaft.

Although the new outlet has not yet been used, the success of the screen placed on the old outlet leads to the belief that the present design will eliminate the trouble due to vortex formation.

Long-Time Road Planning

The Netherlands government recently adopted a 25-year plan for the completion of its highway reconstruction. The total cost is placed at about $200,000. Included in the program are main roads for international travel as well as lines connecting the principal cities. Several large bridges are included, among them two over the Rhine near Arnheim and Nijmegen.

Oklahoma City's Growth Demands Extensive Railroad Changes

Right-of-way of one railroad in central district sold to city for a park and civic center, and a new line built on another location—Grades separated on other railroads and terminals reconstructed

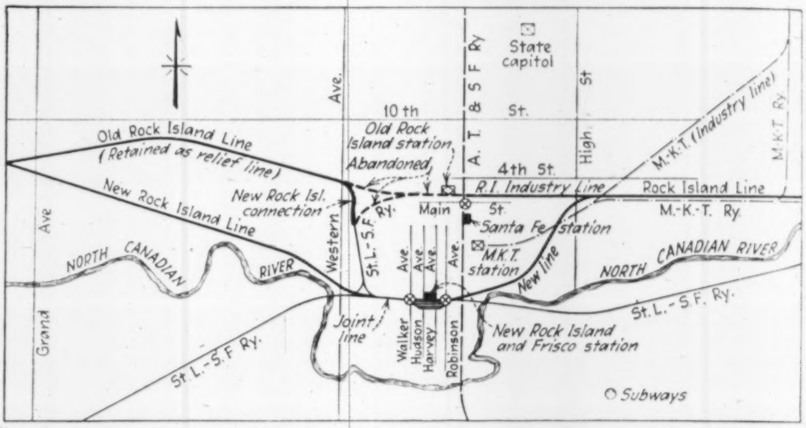
By E. M. Fry
Oklahoma City, Okla. (City Manager, 1927-1931)

GRADE-SEPARATION PROBLEMS resulting from rapid city growth around the original railway location in Oklahoma City, necessitating partial railway abandonment and relocation, are reviewed in the two following articles. In the first, Mr. Fry describes the development and solution of the problem. The second deals with the engineering works involved, including track elevation and subway design, in which exclusion of floodwaters and expediting of heavy street traffic were governing factors.
—EDITOR.

WHEN in 1888 the Choctaw Coal & Railroad Co. secured a government grant for a right-of-way from a point in what was then Indian Territory, near the present town of Hartshorn, Okla., northwest to Goodwin, Okla., there was little thought that the country along this route would develop to such an extent that the successors to the grant would be paid several million dollars of public funds to abandon only about ½ mile of the railroad. Previous to the opening of the Oklahoma country to settlement in 1889 the present site of Oklahoma City was a cattle range with a sidetrack and shanty station on a north and south line of the Atchison, Topeka & Santa Fe Railway. Soon after this opening for settlement the Choctaw Railroad made a location for its line westward through the new town site of Oklahoma City, the plat being filed at Washington and approved by the secretary of the interior.

As soon as the town site was laid out, lots were quickly preempted by settlers. But when the railroad began construction it was opposed by settlers who held lots covered by the location survey, with the result that the railroad proposed a new location 2 miles farther north in order to avoid the town site. With far-sighted ideas and civic spirit the people raised about $20,000 to buy the necessary land from the settlers and thus retain the railroad. Residents vouch for the story that as the new citizens had little money but an abundance of confidence they evolved a plan by which the owners of the numerous saloons advanced the necessary funds and took city scrip, which was in turn accepted by the city in payment of saloon license fees. By this plan the railway was located on its own right-of-way through what became the heart of a city which 40 years later voted a bond issue of $4,000,000 to remove the railroad from the business district.

The Choctaw line was completed in 1892, and the old station (removed in 1931) was built in 1899. The railroad was acquired by the Chicago, Rock Island & Pacific Railway in 1902. Owing to the rapid growth of the new territory, and later to the discovery of vast oil resources, the city's population increased rapidly to 10,000 in 1902 and 200,000 in 1930. Under these conditions and with the railroad developing into a trunk line, with trains crossing the busy main streets at frequent intervals, plans for grade separation were discussed within twenty years after the opening of the railroad. Track depression on the original location, with street viaducts over the line, was proposed by the city; but the railroad preferred track elevation with street subways.



Relocation removes railways from central section of Oklahoma City and involves construction of grade separations and two new passenger stations.

Relocation adopted

In 1927, after prolonged controversy, a relocation of the line outside the business district and separation of grades at intersecting streets was agreed upon by a committee representing the citizens, the city administration and the railroads. This plan was subject to the approval of the people in voting an issue of $4,000,000 in bonds with which to acquire railroad property in the heart of the business district and occupied at that time by the Rock Island and the St. Louis-San Francisco railroads for trackage and station facilities. This bond issue was carried in 1928 by a 7 to 1 vote.

Originally the Rock Island line ran directly through the central part of the city on a private right-of-way between 1st and 2d Sts., as shown on the accompanying map. A few years later the St. Louis-San Francisco built a connection from its own line, ¾ mile south, to the same district. With the new 7-mile diversion the Rock Island now loops south of the business district and is adjacent to the St. Louis-San Francisco right-of-way. That part of the old line within the business district, about ½ mile in length, is abandoned, but the portions east and west are retained for industry purposes, while a new connection curve with the St. Louis-San Francisco spur at the west side enables Rock Island freight trains to be operated over the old route as a relief line. Formerly the St. Louis-San Francisco trains were diverted to the Santa Fe line in order to use the latter's station. But a new union station now serves the adjacent main lines of the Rock Island and the St. Louis-San Francisco.

Following the elimination of these east and west lines from the business district, the Santa Fe undertook to elevate its north and south line and improve its terminals. The Missouri-Kansas-Texas Railroad makes this city a terminal point, with its station on the east side, so that it was not involved in the work of the other lines for the relief of the central business district. However, in 1921 it improved its entrance by a 2¼-mile cutoff that eliminated ten grade crossings, the old line being retained for industry service (*ENR*, Sept. 15, 1921, p. 440).

The tract or right-of-way sold to the city and abandoned by the railways.

about ½ mile long and 100 to 400 ft. wide, comprises about 20 acres and is to be utilized as a public park under the terms of the bond issue. After many legal delays this municipal work is now well advanced. The old station built in 1899 has been demolished, and it is likely that public buildings will be erected around the park in establishing a civic center.

All construction expenses for the new line and improvements are paid by the railroads, including the subway paving, and there is no considerable disturbance of underground facilities, as the streets are not materially depressed at the subways. The only construction expense to the city is for new storm sewers carried under the subways and for certain additional subways beyond those provided for originally, as well as the widening of some that were included in the contract.

The advantages of removal of tracks from the streets are already apparent, and future development of the city will demonstrate that the purchase of the railroad property in the central district was well worth the amount paid for that property.

Special Railway Changes at Oklahoma City

Grade-separation subways designed to expedite traffic and exclude floodwaters—New stations and freight terminals built—Seven miles of one railway diverted

UNUSUAL CONDITIONS leading to extensive railway improvements at Oklahoma City have been reviewed in the preceding article, which is supplemented by the following particulars of the engineering works, some of which present special features in design. Briefly, the Rock Island has abandoned a part of its line through the central district, the right-of-way being purchased by the city. It has therefore built a diversion line eliminating grade crossings, while in conjunction with the St. Louis-San Francisco Railway it has built a new union station. As part of the series of improvements the Atchison, Topeka & Santa Fe Railway is elevating its tracks, eliminating grade crossings of streets and railways, and is also building a new passenger station and terminal facilities.

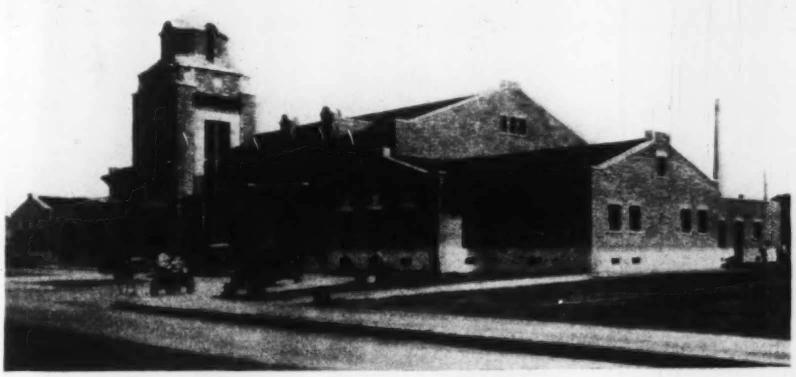
Rock Island Railroad relocation

Having agreed to abandon its original surface line through Oklahoma City, retaining only part of the trackage for industry service, the Rock Island has built a detour, crossing the city some distance south of the old location and north of the North Canadian River. This new line is about 7 miles long, with maximum grades of 0.10 to 0.50 per cent.

Since the new line is adjacent to the right-of-way of the St. Louis & San Francisco Railway in passing through the business section of the city, as shown by the map accompanying the previous article, the two roads have built a union station occupying about a block between Harvey and Hudson Sts. The street front of the station is shown in Fig. 1. Both the tracks and station facilities are about at street level, a ramp leading down from the concourse to a subway under the tracks, from which stairs and elevators provide access to the platforms. Three passenger platforms, 1,000 to 1,200 ft. long and 22 ft. wide, have butterfly shelter roofs. There are six passenger tracks, with through-freight tracks on each side, making a total of eleven tracks through the station.

As Robinson and Walker Aves., which flank the station, are main traffic arteries, they are carried under the railroads by subways. The intermediate streets had never been opened across the tracks in this part of the city. The cost of the improvement has been about $1,250,000 for the diversion line and $2,200,000 for the station and subways, the latter item being shared equally by the two railways.

Fig. 1—Union station at Oklahoma City for Rock Island lines and St. Louis-San Francisco Railway.



Special subway design

Provision for control of traffic, exclusion of river floodwater and handling of stormwater are special features of the Rock Island subways. To provide for the street-car line, the Walker Ave. subway has two 27-ft. roadways, separated by a central bent and giving 15-ft. clear headroom. On each side is an 8-ft. walk, at a higher elevation than the roadway and with a headroom of 8 ft., as shown by Fig. 2. On the approaches the sidewalk width is 6 ft. The total length between points of chain in street grade is 826 ft., with inclined approaches on 8 per cent grades for the roadways. For Robinson Ave. the subway is of similar design, but with a single 36-ft. roadway, as it has no street-car line. Its total length, including inclined approaches, is 904 ft.

A very unusual arrangement is that on both sides of the inclined approach is a 16-ft. driveway at street level, with a connecting span over the subway and adjacent to the railroad property. With this upper-level loop driveway, as shown in Fig. 3, traffic from industries

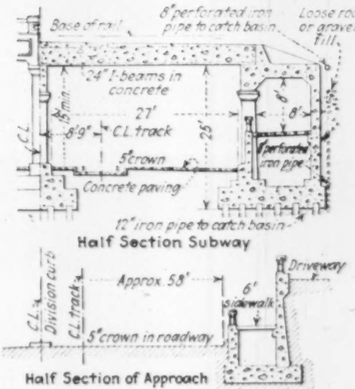


Fig. 2—Subways under Rock Island Railroad keep pedestrians out of roadway, while center curb on open approaches prevents cars from cutting into traffic from opposing direction.

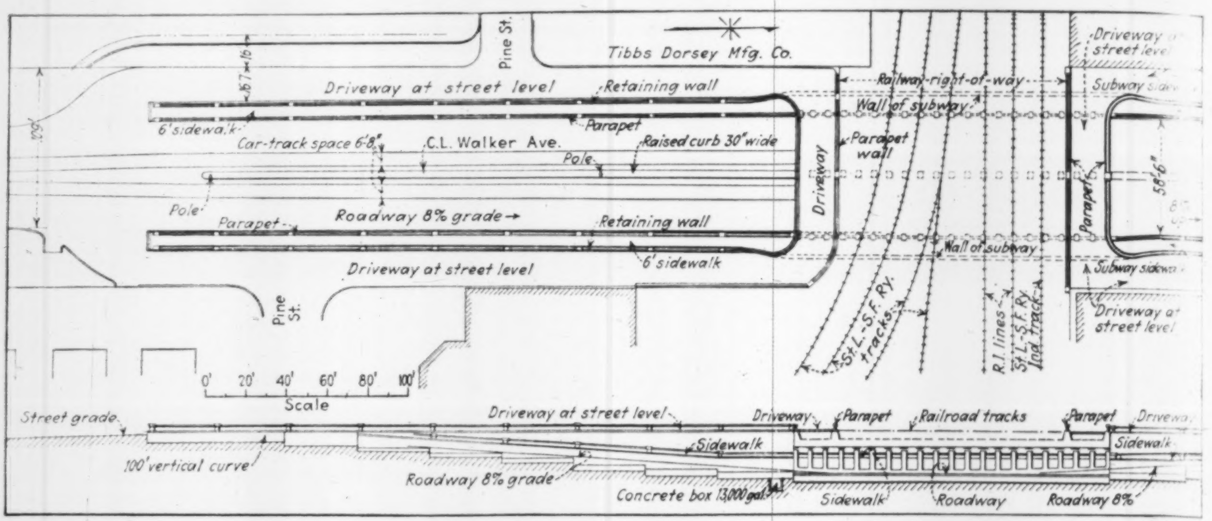

Pine St.
Tibbs Dorsey Mfg. Co.
16.7
16
109'
Driveway at street level
Retaining wall
6' sidewalk
Parapet
Car-track space 6'8"
C.L. Walker Ave.
Raised curb 30" wide
Pole
Pole
Roadway 8% grade →
Parapet
Retaining wall
6' sidewalk
Driveway at street level
Pine St.
0' 20' 40' 60' 80' 100'
Scale
Driveway
Railway-right-of-way
Wall of subway
Parapet wall
Wall of subway
St.L.-S.F. Ry. tracks
R.I. lines
St.L.-S.F. Ry. Ind. track
Driveway at street level
Subway sidewalk
58'-6"
Parapets
Subway sidewalk
Driveway at street level
Street grade
100' vertical curve
Driveway at street level
Sidewalk
Roadway 8% grade
Concrete box 13,000 gal.
Driveway
Parapet
Railroad tracks
Parapet
Driveway
Sidewalk
Sidewalk
Roadway
Roadway 8%

Fig. 3—Subways on busy streets are designed to permit traffic on cross-streets to pass over the approaches and so avoid interference with heavy traffic.

along the railroad and on cross-streets intercepted by the inclines can make a U-turn over the subway without going to the far end of the incline and crossing or intercepting the heavier traffic through the subway. This plan was adopted in order to keep the subway traffic free from interference.

At the Walker St. subway the inclined roadways are separated for their entire length by a curbing 30 in. wide, which provides location and protection for the electric light and trolley poles and serves to keep the traffic divided. Both subways are of reinforced concrete, with precast slabs for the deck spans.

Traffic Control—When the proposed subway construction was being discussed between the representatives of the city and the railway there was considerable municipal agitation for a wider subway on Walker Ave., on the ground that the street traffic was so heavy that it could not be accommodated adequately by the two 27-ft. roadways. On the other hand, it was pointed out that the design specially provided for freedom of traffic movements by excluding cross-traffic and preventing pedestrians from crossing the roadway.

It was estimated by the railway engineers that 4,800 vehicles per hour could be handled through the subway, in addition to street cars, but the opposition's estimate was 2,000 vehicles. However, the design described here was adopted, and recent traffic counts indicate that nearly 6,000 vehicles per hour could be handled. This high capacity is due to the fact that a driver knows he has a clear passage as soon as he enters the approach, for there can be no cutting in of opposing traffic and no possibility of a pedestrian crossing the roadway. In fact, many drivers are found to drive through at speeds as high as 45 m.p.h.

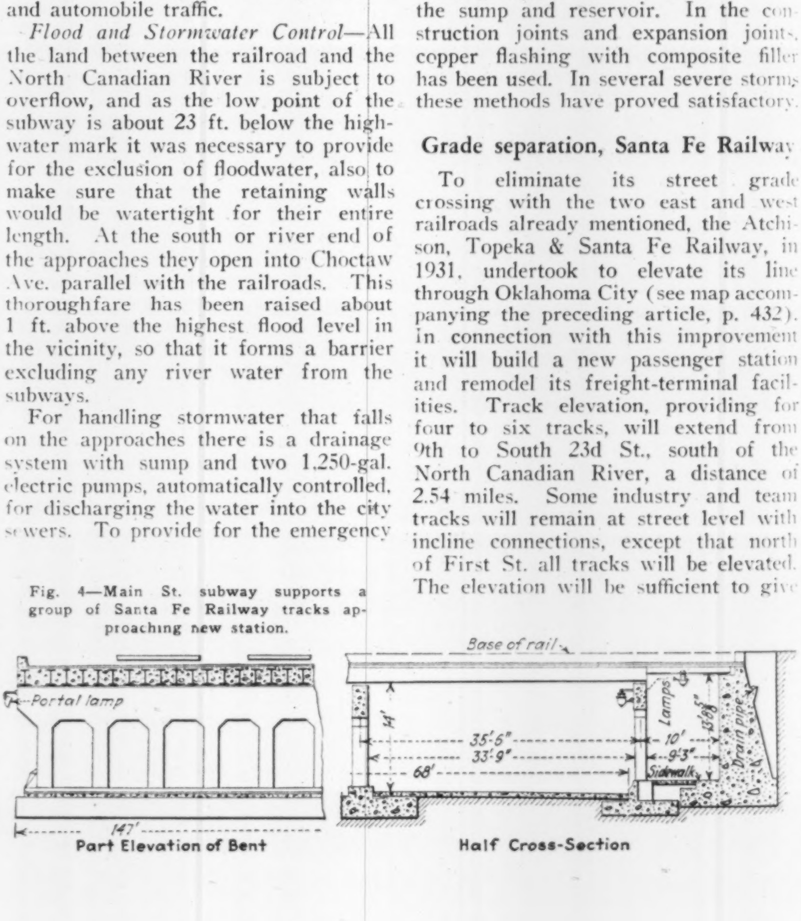
Four points may be noted in this traffic control or traffic capacity of the subways: (1) the central bent and curbs effectually separate traffic in the two directions; (2) no cross-streets enter the approaches; (3) traffic from cross-streets can pass over the heavily traveled approaches; (4) pedestrians are confined to sidewalks, which are at a higher level than the roadway and have handrails or parapets, thus protecting the safety of both pedestrian and automobile traffic.

Flood and Stormwater Control—All the land between the railroad and the North Canadian River is subject to overflow, and as the low point of the subway is about 23 ft. below the high-water mark it was necessary to provide for the exclusion of floodwater, also to make sure that the retaining walls would be watertight for their entire length. At the south or river end of the approaches they open into Choctaw Ave. parallel with the railroads. This thoroughfare has been raised about 1 ft. above the highest flood level in the vicinity, so that it forms a barrier excluding any river water from the subways.

For handling stormwater that falls on the approaches there is a drainage system with sump and two 1,250-gal. electric pumps, automatically controlled, for discharging the water into the city sewers. To provide for the emergency condition of the pumps being out of commission during a heavy storm, a storage reservoir has been built under the south end of the subway, extending the full width of roadway and having a capacity of about 12,000 gal. It is considered that this will keep the subway drained for enough time to allow repairs on the pumping plant.

To insure watertightness of the retaining walls, perforated pipes are placed behind them and led to the drainage system, which connects with the sump and reservoir. In the construction joints and expansion joints, copper flashing with composite filler has been used. In several severe storms these methods have proved satisfactory.

Fig. 4—Main St. subway supports a group of Santa Fe Railway tracks approaching new station.


Portal lamp
147'
Base of rail
14'
35'-6"
33'-9"
68'
Lamps
10'
9'3"
13'8"
Sidewalk
Drain pipe

Part Elevation of Bent

Half Cross-Section

Grade separation, Santa Fe Railway

To eliminate its street grade crossing with the two east and west railroads already mentioned, the Atchison, Topeka & Santa Fe Railway, in 1931, undertook to elevate its line through Oklahoma City (see map accompanying the preceding article, p. 432). In connection with this improvement it will build a new passenger station and remodel its freight-terminal facilities. Track elevation, providing for four to six tracks, will extend from 9th to South 23d St., south of the North Canadian River, a distance of 2.54 miles. Some industry and team tracks will remain at street level with incline connections, except that north of First St. all tracks will be elevated. The elevation will be sufficient to give

14 ft. of clear headroom at the thirteen street crossings and 22 ft. over the Rock Island Railroad and St. Louis & San Francisco Railway.

In general, the fill will consist of sand confined by reinforced-concrete retaining walls of the cantilever type, built partly on concrete piles and partly on spread footings. A new double-track bridge has been built over the North Canadian River, with seven ballasted deck-girder spans of 105½ ft. on eight concrete piers sunk to rock in open caissons.

The new passenger station, on the site of the present structure south of Main St., will have its main floor and concourse at present track level, the concourse extending under the elevated tracks and having stairways to the track platforms. Elevators will handle baggage, mail and express. There will be four passenger tracks with two island platforms 21 ft. wide, together with two freight tracks on the east side. At the north end will be three stub tracks for storage of sleeping and passenger cars. Main tracks will be laid with 110-lb. rails, while sidings and industry connections will have 90-lb. rails.

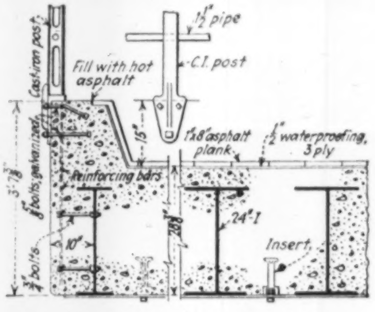


Fig. 5—Slab spans for Santa Fe subways at Oklahoma City. Spans over railway tracks have inserts for attaching blast plates.

During construction all traffic is confined to the east side of the right-of-way while the west retaining walls and west half of subways are being built. The fill will then be placed on the west side of the elevation by means of cars dumping from trestles, after which tracks will be laid on the fill to carry traffic while work is being done on the east side. At the end of 1931 this project was 26.7 per cent completed. As it is to be completed entirely by July, 1933, careful coordination of all parts of the work is essential to insure steady progress and avoid delays.

Design of street underpasses

Street subways will consist of mass concrete abutments and concrete bents at curb lines and center of streets, supporting spans of I-beams embedded in concrete and carrying ballasted tracks. Roadway widths range from 20 to 47 ft., with sidewalks 4 to 10 ft. wide. Typical construction is shown by the Main St. crossing (Figs. 4 and 5), which is 147 ft. long, with two 33-ft. roadway spans and two sidewalk spans of 9 ft. 3 in. clear. For the roadway spans 24-in. I-beams spaced 24 in. c. to c. are embedded in concrete 28¾ in. thick and flush with the bottom flanges of the I-beams. A three-ply waterproof coat on the concrete is protected by a layer of 1x8-in. asphalt plank, upon which the track ballast is laid. A light 24-in. I-beam under the side wall serves as an attachment for the reinforcing in the exposed face of the concrete. Pipe handrailing is carried in cast-iron posts. In the sidewalk spans 12-in. I-beams are used.

Spans over the railroads are identical with the roadway spans, but malleable-iron inserts in the concrete provide for the attachment of blast plates over the tracks.

City and railway personnel

In the negotiations for these extensive improvements at Oklahoma City the city's interest has been represented largely by the city manager. E. M. Fry held this position from 1927 to 1931. At present L. M. Bush is city engineer, and Albert McRin is city manager. The Rock Island work was done under W. H. Petersen, chief engineer; I. L. Simmons, bridge engineer; and H. T. Livingston, engineer of construction (now division engineer). The St. Louis-San Francisco work was under F. G. Jonah, chief engineer, with H. E. Bailey as resident engineer, while the union station was designed by R. C. Stephens, architect for the railway. Work on the Santa Fe improvements was under the direction of G. W. Harris, chief engineer of the Atchison, Topeka & Santa Fe Railway System, and W. W. Wagner, chief engineer of Eastern lines, with H. L. Hunter, engineer of track elevation, in direct charge. The station was designed by E. A. Harrison, architect of the railway, and the subways by R. A. Van Ness, bridge engineer of the Santa Fe System.

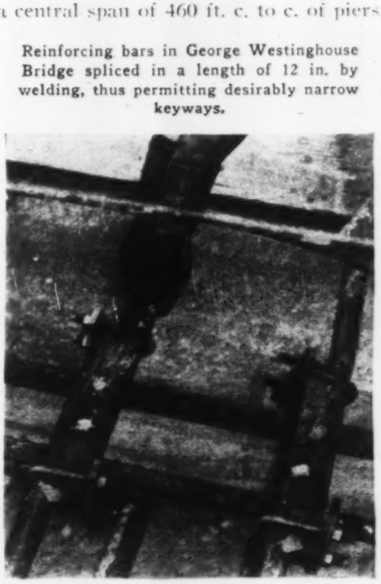
◆

Welding Reinforcing Steel in the George Westinghouse Bridge

STEEL-ROD reinforcement in the five concrete arches of the George Westinghouse Bridge, at East Pittsburgh, Pa., utilizes welded splices at all keyways, an expedient that permitted an unusually narrow width of key, about 4 ft. At other points within the arch ribs, splices were made by wiring and clamping, the overlapping lengths being about 6 ft. In the keys where welded splices were used an overlap of only about 1 ft. was required.

The George Westinghouse Bridge consists of a series of five arch spans—a central span of 460 ft. c. to c. of piers, two symmetrical side spans of 295 ft., and two unsymmetrical end spans of 196 and 277 ft., respectively. Each arch includes two ribs. The ribs of the central arch are reinforced with seventeen 1¼-in. square rods top and bottom, while fourteen 1¼-in. square rods are used top and bottom in the other spans. In general, there were three keys in each arch rib. The reinforcing rods were assembled and held in position in the ribs by steel frames spaced 15 to 25 ft. apart.

Reinforcing bars in George Westinghouse Bridge spliced in a length of 12 in. by welding, thus permitting desirably narrow keyways.



One of the welded splices in the top of one of the ribs is shown in the accompanying illustration. Here the transverse rods are underneath the longitudinal spliced bars. In the bottom of the rib the transverse rods are on top. At both locations the transverse rods are welded to the longitudinal bars by down welding. According to the Westinghouse Electric & Manufacturing Co., whose equipment was used and in whose shops the welders were trained, the key splices, temporarily wired, were welded about five days after the rest of the rib had been poured. In preparation for welding, the rods were firmly clamped near the ends, one of the rods being slightly twisted to form a V-section between the rods, thus giving a maximum surface for weld fusion. A burn-in-bead weld was then placed along the line of contact for the full length of the splice, followed by a wider bead weaved in over the burn-in weld, giving a solid fillet with a throat dimension of ½ in. and in most cases a width of ¾ in. The clamps were not removed.

Need for Speed With Economy Governs Santa Fe Bridge Design

Alternative designs compared by study of construction periods required—Unusual span of 100 ft. for main towers adopted —Deep cylindrical piers sunk by caisson and open dredging

By Theodore Doll

Assistant Engineer,
Atchison, Topeka & Santa Fe Railway System

VIADUCT TOWER SPANS of the unprecedented length of 100 ft. are conspicuous in the design of the new Canadian River bridge of the Atchison, Topeka & Santa Fe Railway. Selection from several alternative designs was based principally upon the time required for construction, since a study of the conditions showed that the date of opening the line would depend upon that of completing the bridge, which in turn would depend upon the type of structure selected and the completion of its foundations.

—EDITOR.

IN THE NEW 122-mile line of the Atchison, Topeka & Santa Fe Railway from Amarillo, Tex., to Boise City, Okla., the Canadian River is crossed by a bridge having its four main-truss spans carried by tall steel towers. This bridge, 20 miles north of Amarillo, is a single-track ballasted-deck steel structure, on a straight and level line, designed for Cooper's E-65 loading. It includes four 220-ft. Warren-truss deck spans, four 100-ft. tower spans, two 60-ft. tower spans, four 70-ft. deck-girder spans and two 28-ft. I-beam spans. Its length, end to end of steel, is 1,735 ft., and the total weight of steel is 3,220 tons. The base of rail is 114½ ft. and 100½ ft. above extreme low and high water, respectively. A view looking north is given in Fig. 1, with a drawing of a typical portion of the structure in Fig. 2.

Each of the ten channel piers consists of two independent cylindrical caissons, sunk from 46 ft. (in hard shale) to 117 ft. (in sand) below the normal ground level, the maximum depth below extreme low water being 105 ft. The transverse distance between pairs of caissons varies from 33 ft. 10⅛ in. to 51 ft. 1⅜ in., c. to c., depending on the height of the steel columns and the spacing of girders or trusses. In each 60-ft. tower the uphill bent rests on two pedestals with spread footings. The remaining bank piers are of the ordinary mass-concrete type, but the extreme ends of the bridge are carried by buried skeleton piers instead of the usual wing abutments.

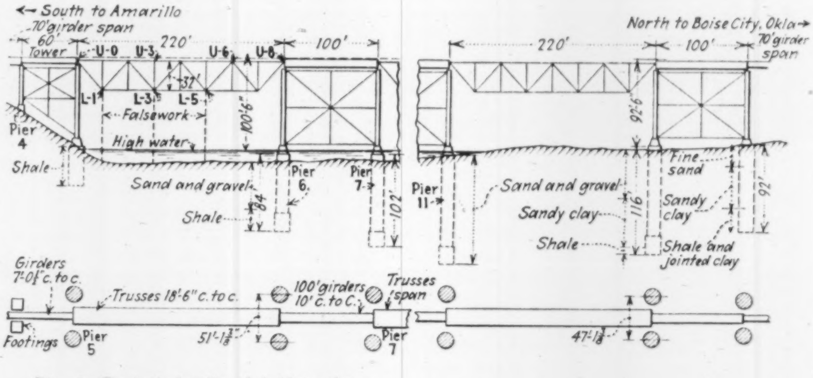


Fig. 2—Typical details of bridge, showing deep foundations, long towers and different transverse spacing of alternate spans.

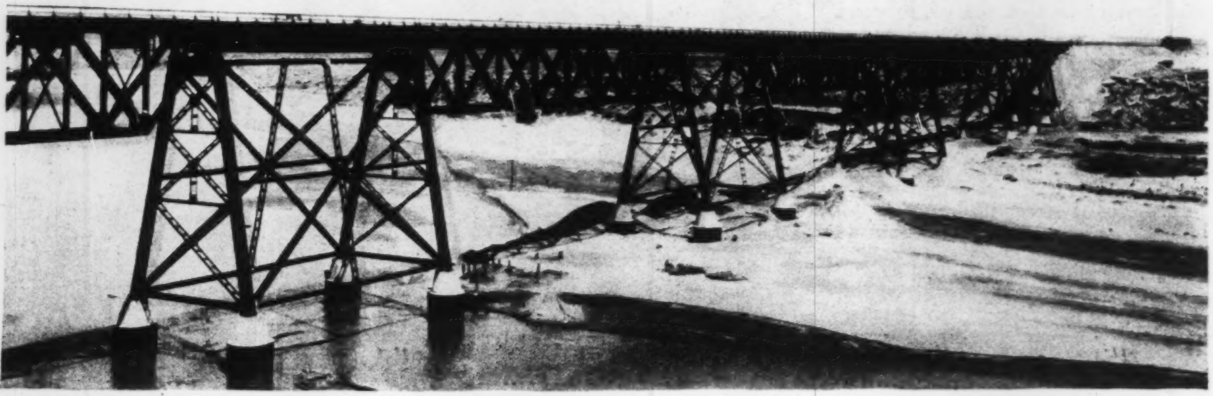
The bank piers rest on either shale or jointed clay, except that pier 17, the last one at the north end, is on a ledge of limestone cap rock.

Selection of design

The site chosen was that which resulted in the lowest estimated cost for the entire new line, based upon comparative estimates for alternative locations. In deciding on the type of structure the two governing considerations were economy and time. It was seen that the date of opening the railway would depend entirely upon the date of completing the bridge. As the steel erection could be (and was) so planned as to be finished shortly after the last pier had been built, it became evident that the opening would depend principally upon the time required to complete the bridge foundations.

Comparative estimates were made for structures having main channel spans of three types: (*A*) truss spans supported by concrete piers on deep caissons; (*B*) steel towers supporting intermediate girder spans and resting on cylindrical caissons; (*C*) steel towers

Fig. 1—The Canadian River bridge of the Santa Fe Railway is notable in that it has four deck-truss spans carried by towers of the unusual length of 100 ft.



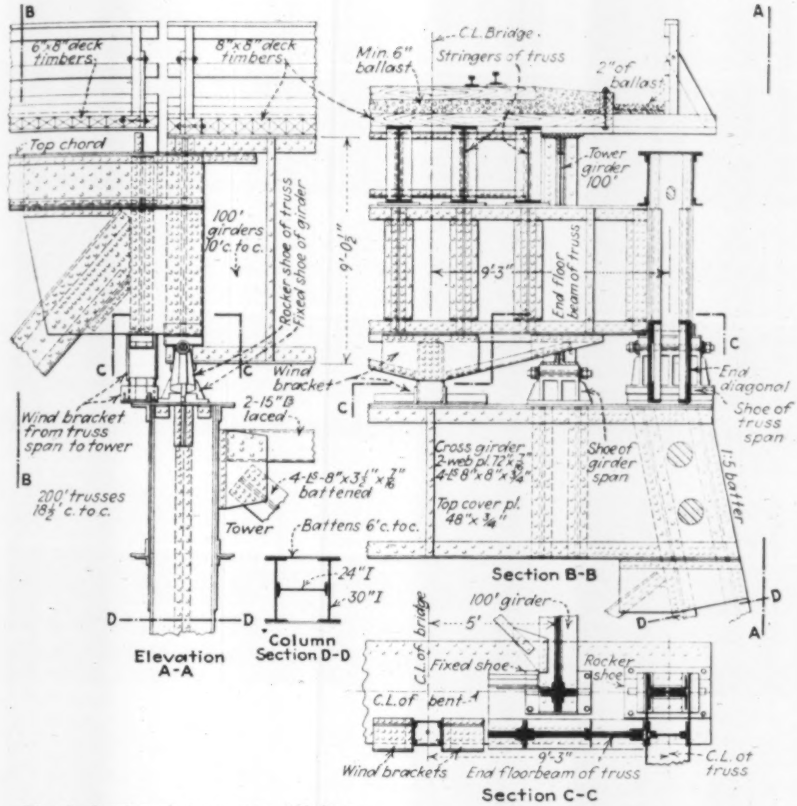

B
6"x8" deck timbers
8"x8" deck timbers
Top chord
100' girders 10' c. to c.
Rocker shoe of truss
Fixed shoe of girder
9'-0½"
C
C
Wind bracket
Wind bracket from truss span to tower
2-15" ⊏ laced
B
200' trusses 18½' c. to c.
4-∟s-8"x3½"x7/16" battened
Tower
Battens 6' c. to c.
24"I
30"I
D
D
Column Section D-D
Elevation A-A
C.L. Bridge
Min. 6" ballast
Stringers of truss
2" of ballast
A
Tower girder 100'
9'-3"
End floor beam of truss
C
End diagonal
Shoe of truss span
C
Cross girder 2-web pl. 72"x7/16" 4-∟s 8"x8"x¾"
Shoe of girder span
1:5 batter
Top cover pl. 48"x¾"
Section B-B
D
A
100' girder
5'
C.L. of bridge
Fixed shoe
Rocker shoe
C.L. of bent
Wind brackets
9'-3"
End floorbeam of truss
C.L. of truss
Section C-C

Fig. 3—Seating of the trusses, 18½ ft. c. to c., and girders, 10 ft. c. to c., on the towers simplified the tower-bent design.

supporting intermediate truss spans and resting on cylindrical caissons. This last was the type selected. A sufficient number of estimates was made for each of the three types to determine the combination of span lengths that would result in the lowest total cost. For each type of structure these estimates showed that the more nearly the ratio of the cost of superstructure to substructure approached unity, the less the total cost of that particular type. Comparative data for the three lowest estimates are given in the table below.

COMPARISON OF BRIDGE DESIGNS

Type of Structure	Span Lengths — Towers	Span Lengths — Intermediate	Ratio of Costs	Ratio of Cost of Steel to Foundations
A	None	300 ft.	A/C = 1.39	1.01
B	100 ft.	100 ft.	B/C = 1.15	0.42
C	100 ft.	220 ft.	....	1.06

For type A it was not desirable to use long truss spans, on account of the likelihood of a washout during erection, as observations at other bridges on this river had revealed great depth of scour. For type B it was not desirable to use girders of more than 100-ft. span because of the distance necessary to boom out for erection and the strong winds prevailing at the bridge site: For type C, the use of truss spans longer than those adopted would have required larger caissons, so that 220 ft. became the economical intermediate span length. All the alternative schemes involved either more or larger caissons than the selected design, as well as larger volumes of excavation and concrete. They would have required, therefore, either a larger construction plant or a longer period of construction. Furthermore, the estimates showed that the structure of lowest cost was also the one that would be expected to require the shortest time for completion of the foundations.

Long tower spans

In the four channel towers the length of 100 ft. c. to c. of bents is without precedent. The longest previous tower spans are, apparently, 70 ft. in the Santa Fe Railway viaduct over the Alhambra Valley, built in 1928, and 67 ft. in the Lethbridge viaduct on the Canadian Pacific Railway (*ENR*, Sept. 23, 1909, p. 324). Theoretical investigation did not reveal any insurmountable objections to the 100-ft. towers, while the consequent reduction in the number of piers resulted in an important saving in cost and time.

Special features in design

Deck spans were used because there were no clearance limitations making through-spans necessary, a substantial saving of steel resulted, the overturning effect of wind would be reduced, and it was desirable to avoid overhead steel that would be subject to corrosion by smoke. The "underslung" type of deck truss was adopted, instead of the "square-end" type, to improve the appearance of the bridge, to simplify the steel details and to avoid carrying the tower spans on the ends of the truss spans.

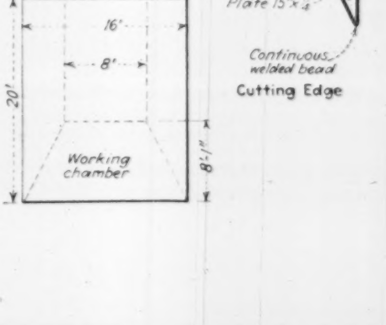
Trusses are spaced 18 ft. c. to c., while the 100-ft. tower girders are 10 ft., and all other tower and girder spans 7 ft. ½ in. c. to c. From Fig. 3 it will be noted that the end floor beam of the truss span was set back from the usual position above the center of bearings. This enabled the ends of the tower girders to be placed between the trusses. The shoes of both spans were then located along the center of the bent, and eccentric loading of the columns was thus avoided. The single-rocker type of expansion shoe was used, as the Santa Fe System has abandoned roller-nest shoes. The former are lighter in weight, lower in cost and require no maintenance; whereas roller-nest shoes require frequent cleaning and oiling.

Omission of transverse bracing between the end diagonals of the truss spans is a feature that saved detailing, erection and steel. The bottom lateral forces are carried to the top through the end vertical cross-frames and back to the shoes through the top laterals in the end panels.

Construction of foundations

The caissons used for seven of the channel piers are as shown in Fig. 4. Those of the other three channel piers were 16 ft. in diameter for the full depth, but the caissons that were enlarged at the bottom were easier to sink and easier to control as to position. Six vertical air-jet pipes extended to the cutting edge. Although the light cutting edge was crushed, more or less, after reaching hard material, the damage was not such as to cause trouble. In the seven cylinders that were sealed under air pressure the cutting edge was banked with hand-mixed concrete. This made it possible to get the bottom per-

Fig. 4—Caissons were sunk by open dredging and pneumatic system.


8'
11'
8'
14'
60' to 93'
4'
16'
8'
20'
8'-1"
Dredge well
Working chamber
¼" plate
7/8" bar
5/8" bar
6 Equidistant diaphragms 8"x¼" plates welded
Plate 15"x¼"
Continuous welded bead
Cutting Edge

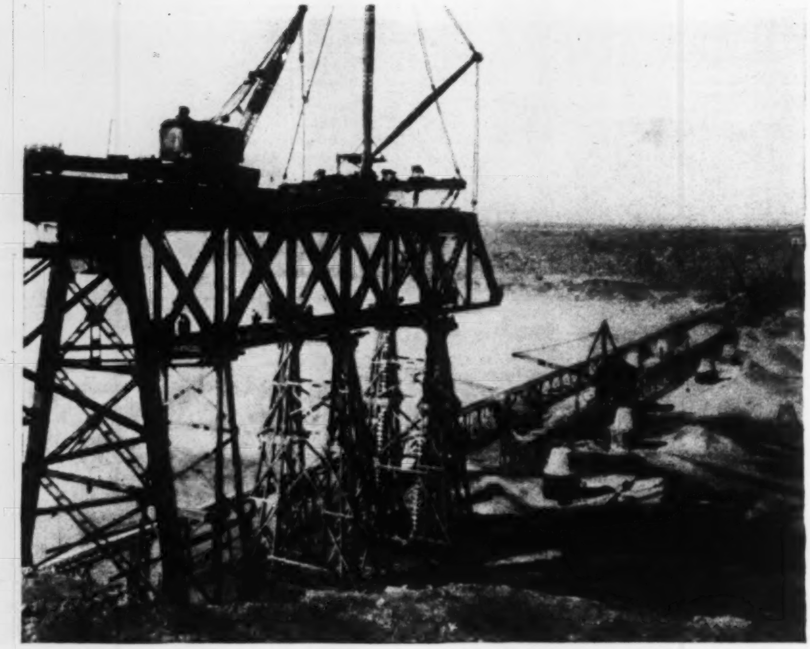


Fig. 5—Erection of 220-ft. deck truss, with falsework at the *L-1*, *L-3* and *L-5* points. The two construction trestles and derricks for the foundation work are shown at the right.

fectly dry before the working chamber was sealed.

Open dredging was highly successful. Seven cylinders of the four piers in sand were sunk entirely by dredging and sealed by tremie; the other was sunk 64 ft. by dredging and then under air. Piers 6 and 7 were dredged through sand to shale and completed under air. Open excavation in clay and shale was practicable at piers 5 and 14 by pumping out the water. These piers were sunk thus to hard shale and then sealed under air. Piers 12 and 13 were sunk 63 and 74 ft., respectively, by dredging and open-hand excavation in sand and sandy clay, and they were completed under air. Only one-sixth of the sinking was by the pneumatic process.

Concrete work

The caissons were served by mule-type derricks operated from a tramway on the center line of the bridge (Fig. 5). Concrete was conveyed from the mixer in 1-yd. drop-bottom buckets on cars drawn by a dinkey on a second tramway, 50 ft. upstream from the other. Sand and gravel, hauled 3 to 5 miles from the pits by trucks, were screened but not washed. The mixer plant was at one end of the site. Although storage piles of sufficient size for an emergency were maintained, the greater part of the aggregates was dumped from the trucks into chutes leading down the bank to a 40-yd. partitioned storage hopper above the $1\frac{1}{4}$-yd. mixer. The derrick shown in Fig. 5 erected the mixer, handled excavated material and concrete for pier 5, conveyed concrete to pier 4, placed concrete in a side-dump car for conveying to piers 1, 2 and 3, and supplied aggregates from the storage piles when necessary.

Underground concrete was designed for 2,000 lb. ultimate strength, and exposed concrete for 3,000 lb. The maximum size of aggregate was 3 to 4 in., except that 6 to 8 in. was permitted for filling the dredge wells, this being the largest that it was advisable to run through the mixer. With this large aggregate, a 2-in. slump and a mix of 1:3.5:6.9, the dredge-well concrete tested 2,200 lb. in 28 days.

Dredge wells were filled by dropping the concrete through a hopper at the top, in one continuous pour, with a maximum drop of 72 ft. Inspection did not reveal any harmful segregation; in fact, the drop apparently helped to compact the material. Some of the dredge wells were filled without having any excess of free water at the top: three of the deepest wells were filled without an appreciable amount of such water; and the remainder showed an equivalent of $\frac{1}{2}$ to $1\frac{1}{2}$ in. of water, the amount depending chiefly upon the depth of the well and the weather conditions.

Foundation work was begun shortly after the grading had been started and four months before the railway from Amarillo reached the site. All of the construction equipment and most of the materials except sand and gravel and a part of the cement were trucked from Amarillo, 21 miles to the south bank and 24 miles to the north bank. After track had been laid to the south bank, the remainder of the cement and a small amount of other material were delivered by rail.

Erecting bridge steel

Steel erection was started soon after the bank piers on both sides of the river had been finished. Although none of the caissons had been completed, 60 per cent of the sinking had been done and 40 per cent of the caisson concrete was in place. Six weeks later the foundations were far ahead of the steel erection, with 88 per cent of the sinking completed and 75 per cent of the concrete placed.

Erection from the south end (Fig. 5) was handled by a guy derrick, which placed up to 390 tons in one week and erected about 85 per cent of all the steel. A locomotive crane served as a feeder. Falsework consisted of two stories of preframed towers of 12x12-in. fir timbers supported on piling. After a truss span had been swung, these framed towers were carried ahead for the next truss span, the same falsework being used for all four spans. Piles for the falsework of the first truss span were driven with swinging leads handled by the guy derrick. Those for the

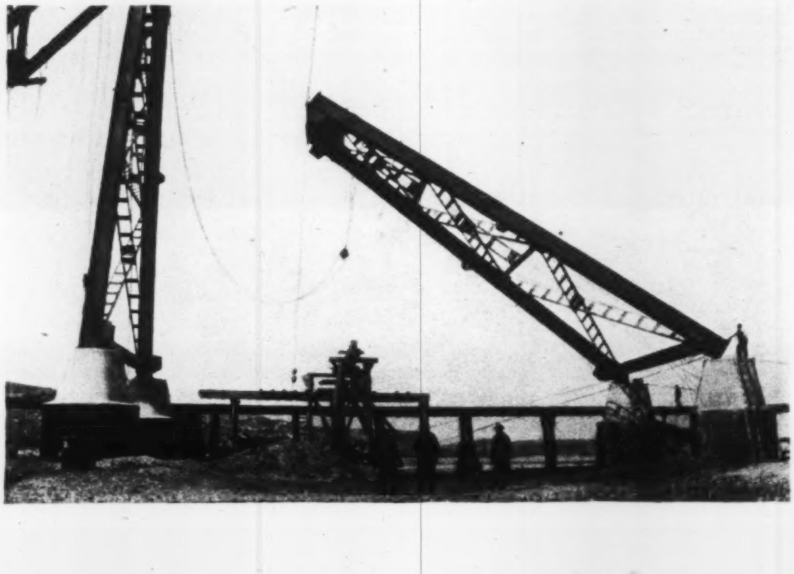


Fig. 6—Raising a bent of a 100-ft. tower on its piers. Movement to vertical position was completed by tackle from head of bent to next pier at right.

next two spans were driven by derricks set free upon the completion of the caissons. The falsework for the fourth truss span, being practically safe from high water, was supported on timber cribbing. Adjusting jacks on top of each falsework tower made it possible to match all holes in the truss members without any drifting.

Truss-span erection

In erecting a truss span (Figs. 2 and 5) the guy derrick first placed the falsework bent at the *L-1* point and the falsework tower at the *L-3* point, working from a location directly above the steel bent at the *U-0* point of the span. Next, the top chord was erected out to the *U-4* point and the bottom chord to the *L-3* point, together with connecting web members, floor beams, stringers and laterals. The derrick then moved to the *U-3* point, directly above the falsework, after which it placed the falsework under the *L-5* point and erected the bottom chord out to *L-7* and the top chord to *U-6*, together with connecting web members, floor system and laterals. It then moved to the *U-6* point, one panel beyond the falsework, and erected the first steel bent of the next tower, followed by the remainder of the truss span. The rockers at the *U-0* point having been blocked, the span was then swung, and the derrick was moved ahead to the *U-8* point over the newly erected bent.

Then the next bent of the 100-ft. tower was assembled in a horizontal position, with the near end supported on a part of the center-line tramway. The far end rested on the cylinder piers and was so located that the base of each column would be in the correct position when the bent was vertical. It was lifted first by the guy derrick, as shown in Fig. 6; but after it had passed the 45-deg. position it was pulled vertical by outhaul cables from the top of the bent to the next pier ahead. Each of these bents in the tower weighed about 56 tons.

To expedite the work, a derrick car was brought to the north side of the river (together with the structural steel required between piers 12 and 17) as soon as track had been laid south from Boise City to the site. Having to work on a new fill, the derrick car was somewhat hampered, although the track had been double-tied to prevent excessive settlement under the heavy load. In spite of this difficulty, the derrick car completed the erection on schedule as far as pier 14. The last foundation (the west cylinder of pier 13) was also finished on schedule. With a high-early-strength mix used in the pedestal, this pier was ready for the steel two days after completion.

Completed on schedule

On the same day that the guy derrick completed the erection from the south to pier 12 and the last truss span was swung, the derrick car completed the erection from the north to pier 13. While the latter erected the last girder span and the longitudinal bracing of the last tower, the locomotive crane dismantled and loaded the guy derrick. Thus the completion of steel erection followed immediately after that of the foundation, as predicted when the preliminary cost estimates were made. Work with the derrick car from the north end was estimated to have advanced the completion of the bridge by fully three weeks.

As the creosoted deck timbers and permanent track had been laid during steel erection, the deck was promptly completed and ballasted, so that regular trains began operating a week after the last steel member in the bridge had been placed.

Engineers and contractors

The design and construction of this new line, including the bridge, were under the supervision of G. W. Harris, chief engineer of the Atchison, Topeka & Santa Fe Railway System. The structure was designed under the direction of R. A. Van Ness, bridge engineer of the system. W. H. Rochester was construction engineer of the new line, with the author as assistant engineer in direct charge. Foundations were built by the Union Bridge & Construction Co., Kansas City, Mo., and the superstructure was fabricated and erected by the American Bridge Co., Chicago.

Largest All-Welded Bridge Built in Czechoslovakia

Highway structure of 161-ft. span involving 145 tons of steel built by large industrial company—Principal members built up of welded plates

By F. Faltus
Chief Engineer, Skoda Works, Ltd., Prague, Czechoslovakia

IN THE FALL of 1931 the first all-welded highway bridge in Czechoslovakia and the largest such structure in the world was opened to traffic in Plzen. The bridge has a span of 161 ft. and weighs 145 tons, so that it is considerably larger than the Chicopee Falls bridge in the United States, as may be seen in Fig. 1, which shows sketches of the four largest all-welded bridges built to date. The new bridge is in the plant of Skoda Works, Ltd., the largest industrial enterprise in Czechoslovakia, and connects the south and north parts of these works, which are separated by two express lines of the Czechoslovakian State Railways.

The general arangement of the bridge (Fig. 2) is interesting: under it is a second bridge, beneath which one of the express lines runs under the other and a works' line. It may also be seen that one of the approaches had to be developed as a serpentine, as there was not sufficient room for a straight ramp. The gradient of the ramp is 6 per cent.

The bridge itself includes two main trusses, 21 ft. 8 in. deep and 27 ft. 4 in. apart. Plate-girder floor beams with 31½-in. web plates are used, while the stringers are rolled sections developed as continuous beams. The roadway (20 ft. 7 in. wide) is granite metaling and is laid on a base of reinforced concrete.

Details of the design may be seen in Fig. 3. The members of the main trusses are of rolled sections and plates welded together, as there are no suitable rolled sections available in this country. In spite of this the cross-section development is very simple. The largest cross-

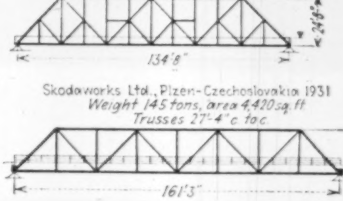

Lowicz-Poland 1929
Weight 55 tons, area 3,000 sq ft
Trusses 21'-5" c. to c.
8'5"
88'-6"
Leuk-Switzerland 1930
Weight 37 tons, area 2,370 sq ft
Trusses 14'-9" c. to c.
10'1"
122'
15'1"
Chicoppee Falls-USA. 1928
Weight 80 tons, area 2,260 sq ft
Trusses 17' c. to c.
24'6"
134'8"
Skodaworks Ltd., Plzen-Czechoslovakia 1931
Weight 145 tons, area 4,420 sq. ft
Trusses 27'-4" c. to c.
21'11"
161'3"

Fig. 1—Of the four largest all-welded bridges in existence, three, including the largest, are in Europe. The Chicopee Falls, Mass., bridge is a railway structure, while the European bridges are for highway use.

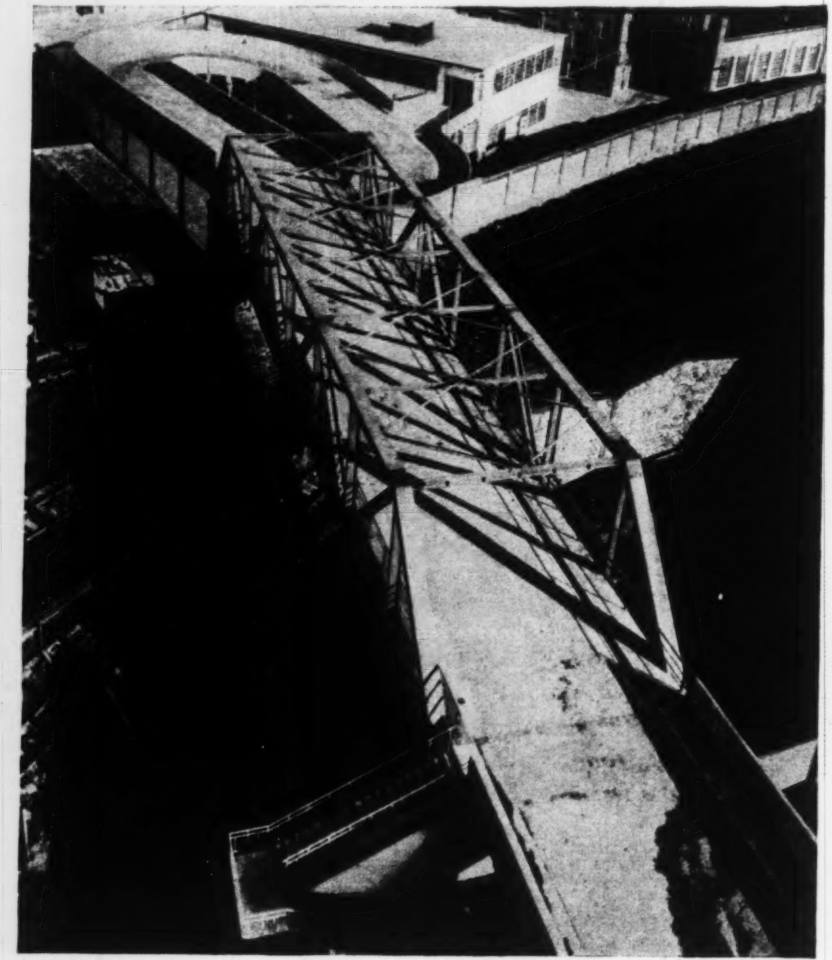


Fig. 2—Latest and largest of all-welded bridges has a span of 161 ft. and is located at Plzen, Czechoslovakia, in a large industrial plant. It passes over two levels of railway tracks. Constricted space at one approach made a spiral ramp necessary. Space beneath the ramp is developed as storage rooms.

section is in the middle top-chord member, which is built up of two web plates $18\frac{7}{8}$x1 in., a coverplate $23\frac{5}{8}$x$1\frac{3}{16}$ in. and diaphragms. The top-chord member transmits a maximum force of 347 tons.

All welding seams are continuous, although in many cases this was not required by stress conditions. The development of the joints in the main trusses is simple. Gusset plates are used only in the end joints, and elsewhere the diagonals can be joined direct to the web plates of the chords. The butt-joints in tension members are reinforced with stiffening plates so that part of the stress may be transmitted by fillet welds.

All welding was by direct current with uncoated electrodes. In all there is 15,158 ft. of welded seams on the bridge, of which 2,165 ft. was welded in the field.

In Czechoslovakia there are at present no regulations governing the design and erection of welded bridges. Therefore, the bridge was designed on the basis of the provisional regulations approved by the railway ministry, which regulations were drawn up by the Skoda Works. The calculations were based on the stresses in Table I.

The shop welders were chosen according to the results of tests that take place in the bridge-building department of the Skoda Works twice a year. The field welders were chosen by special examination in which special weight was placed on skill in welding on a vertical wall. Of the eight welders selected the following average values for single-V butt-welds in tension were attained: (a) $\frac{3}{8}$-in. plate, horizontal position, 52,000 lb. per sq.-in. and vertical position 48,600 lb. per sq.in.; (*b*) 1-in. plate, horizontal position 59,200 lb. per sq.in., vertical position 54,400 lb. per sq.in.

TABLE I — DESIGN STRESSES FOR WELDED BRIDGE IN CZECHOSLOVAKIA (LB. PER SQ.IN.)

Part of Bridge	Base Material	Welds for Tension	Welds for Compression	Shear
Floor skeleton	12,100	7,800	11,400	[illegible]
Main trusses	14,500	9,700	13,800	[illegible]
Including wind stress	19,200	12,800	17,800	[illegible]

TABLE II — DEFLECTIONS OF ALL-WELDED HIGHWAY BRIDGE

	Deflection of the Bridge, In. Measured	Deflection of the Bridge, In. Calculated
From the weight of the steel structure, 145 tons	0.374	0.394
From the weight of the roadway 295 tons	0.630	0.827
Loading test of seven trucks weighing 110 tons	.....	
Left main truss	0.346	0.472
Right main truss	0.433	0.516

Bolts were used to hold the individual parts of the bridge together while they were being welded. The welding was carried out according to a detailed plan determined in advance in order to keep the shrinkage stresses resulting from welding as small as possible.

The deflection of the completed bridge was measured under various loadings and finally at the loading test. Particulars are given in Table II.

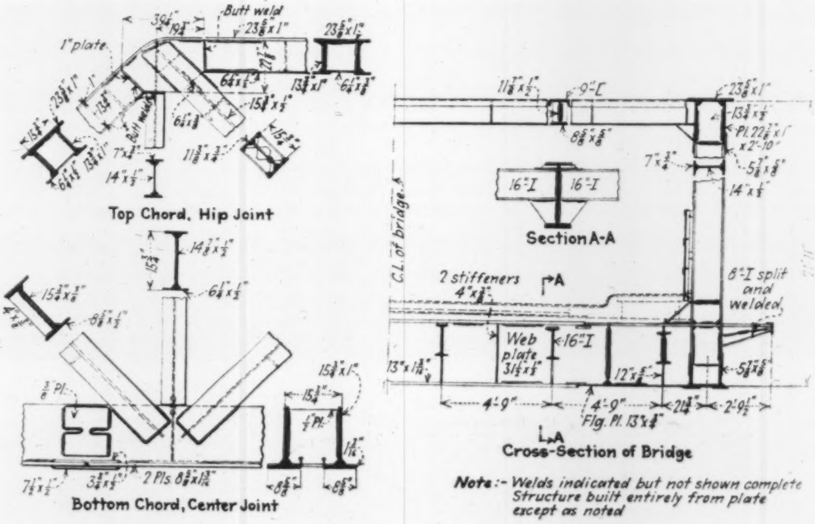


Fig. 3—Members built up of plates welded together form the principal members of all-welded highway bridge in Czechoslovakia, the largest yet built.

Butt weld
1" plate
$39\frac{1}{4}$"
$19\frac{3}{4}$"
$23\frac{5}{8}$x1"
$23\frac{5}{8}$x1"
$21\frac{7}{8}$"
$6\frac{1}{4}$x$\frac{1}{2}$"
$13\frac{3}{4}$"x1"
$6\frac{1}{4}$"x$\frac{3}{8}$"
$15\frac{3}{4}$"x$\frac{1}{2}$"
$6\frac{1}{4}$"x$\frac{3}{8}$"
Butt welds
$13\frac{3}{4}$"
1"
$15\frac{3}{4}$"
$13\frac{3}{4}$"x1"
$6\frac{1}{4}$"x$\frac{1}{2}$"
7"x$\frac{3}{4}$"
$11\frac{3}{8}$"x$\frac{3}{4}$"
$15\frac{3}{4}$"
14"x$\frac{1}{2}$"
Top Chord, Hip Joint
$15\frac{3}{4}$"
$14\frac{7}{8}$"x$\frac{1}{2}$"
$6\frac{1}{4}$"x$\frac{1}{2}$"
$15\frac{3}{4}$"x$\frac{3}{8}$"
4"x$\frac{3}{8}$"
$8\frac{5}{8}$"x$\frac{1}{2}$"
$\frac{3}{8}$" Pl.
$15\frac{3}{4}$"x1"
$15\frac{3}{4}$"
$\frac{1}{2}$" Pl.
$1\frac{3}{16}$"
$7\frac{1}{2}$"x$\frac{1}{2}$"
$3\frac{3}{4}$"x$\frac{1}{2}$"
2 Pls. $8\frac{5}{8}$"x$1\frac{3}{16}$"
$8\frac{5}{8}$"
$8\frac{5}{8}$"
Bottom Chord, Center Joint
$11\frac{7}{8}$"x$\frac{1}{2}$"
9"-[
$23\frac{5}{8}$"x1"
$8\frac{5}{8}$"x$\frac{5}{8}$"
$13\frac{3}{4}$"x$\frac{1}{2}$"
Pl. $22\frac{7}{8}$"x1" x 2'-10"
7"x$\frac{3}{4}$"
$5\frac{7}{8}$"x$\frac{5}{8}$"
14"x$\frac{1}{2}$"
16"-I
16"-I
Section A-A
C.L. of bridge
2 stiffeners 4"x$\frac{3}{8}$"
A
8"-I split and welded
Web plate $31\frac{1}{2}$"x$\frac{1}{2}$"
16"-I
13"x$1\frac{3}{16}$"
12"x$\frac{5}{8}$"
$5\frac{7}{8}$"x$\frac{5}{8}$"
4'-9"
4'-9"
$21\frac{3}{4}$"
2'-$9\frac{1}{2}$"
Flg. Pl. 13"x$\frac{3}{4}$"
A
Cross-Section of Bridge
Note:- Welds indicated but not shown complete
Structure built entirely from plate
except as noted

All-Metal Building for Richmond Public Works Department

First structure of its type for office use in this country utilizes steel frame, bar joist and pressed-steel plate floors and facade of aluminum and glass

THE FIRST all-metal office building to be erected in this country has recently been completed in Richmond, Va., as the new home of the city's department of public works. It is a two-story structure, rectangular in shape, with a frontage of 116 ft. and a depth of 50 ft. A structural-steel frame is utilized, with open-web joist floors and roof covered by pressed-steel deck plates. The inner and outer walls of the building around the columns make extensive use of aluminum. In the outer walls extruded shapes and plate are used, the latter being employed to produce a drop-panel effect in the pilasters and entablature. The inner walls are formed from aluminum sheet with insulating material pumped into the intervening space between the outer and inner walls. Steel casement windows extend from the first-floor level to the base of the entablature and form a continuous line between the pilaster columns. The spandrel areas of the windows are backed with aluminum sheet and are insulated in a similar manner to that employed elsewhere in the walls.

A contrast in color and texture is obtained on the exterior of the building by giving the pilasters and entablature a sandblasted finish, and the light metal trim on the windows and between the window frames and pilasters a satin finish. Also, to accentuate this contrast, the window frames are painted black except in the spandrel sections, where both the window panes and frames are painted with aluminum paint. The entrance to the building, including doors and door jambs, is done in satin-finish aluminum.

The partitions on the first and second floors are of satin-finished aluminum sheet over wooden frames. The permanent partitions at the entrance extend to the ceiling, while those between the structural bays extend only to within 3 ft. of the ceiling to provide ventilation for the offices. The ceilings are of plaster applied on metal lath. The finished floor covering is $\frac{1}{8}$-in. asphaltic tile.

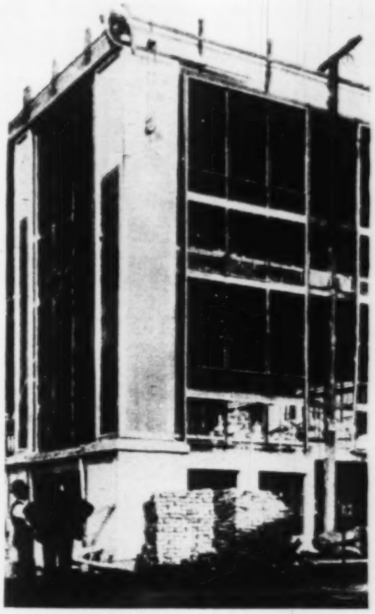


Fig. 2—Erecting an aluminum pilaster on Richmond building. Inclosure materials were unusually light and were received assembled, making erection easy and rapid.

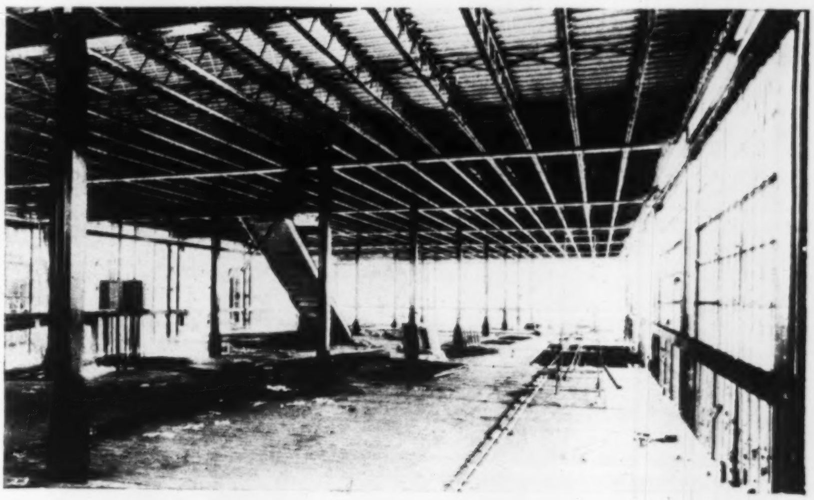
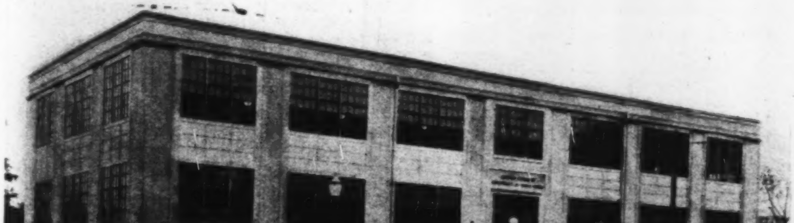


Fig. 3—First-floor skeleton of all-metal building, in which floors of pressed-steel plates bolted to bar joists and walls of steel, glass and aluminum contribute to an economical saving in weight.

Fig. 1—All-metal office building built to house department of public works of Richmond, Va. Steel casement windows comprise the walls, with panes and frames in spandrel areas painted with aluminum paint. Column pilasters and entablature are of sheet and extruded aluminum.



In the structural-steel frame the columns below the first-floor level consist of 8x8-in. 31-lb. H's; above this point they are of 6x6-in. 20-lb. H's. Floor girders are 12-in. channels and I-beams, and 10-in. channels and I-beams are used for the roof girders; both the floor and roof girders extend in one direction only. Each structural bay is 16 ft. 6 in. by 16 ft. 8 in.

Open-web bar joists, bolted at the top and bottom to the structural girders, are used for both the floor and roof beams. Special pressed-steel plates bolted to the joists serve as the floor

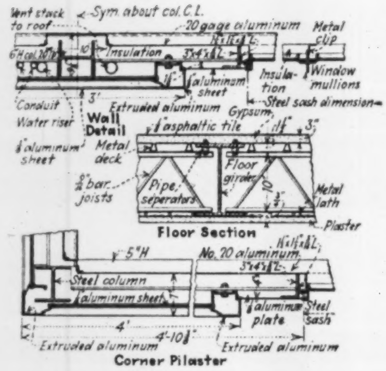


Fig. 4—Structural details of all-metal office building. Wall sections show facility with which aluminum, steel frame and windows were combined. Light-weight floor and wall insulation are notable.

and roof decking. The roof is covered with five-ply slag roofing on insulating boards cemented to the steel decking. The floor fill is 3 in. of gypsum, poured in place and unreinforced. The floors are designed for a live load of 80 lb. and a dead load of 20 lb. per sq.ft.; the roof is designed for 30 and 15 lb. respectively.

The walls of the building are from $3\frac{1}{2}$ to 7 in. thick and, together with the insulating material, average in weight less than 10 lb. per sq.ft.

The construction of the building was greatly simplified, and the time required for erection was materially reduced because of the ease and simplicity with which the parts were assembled. A construction period of four and one-half months was required. The building has a volume of 222,244 cu.ft., and without such accessories as partitions, floor coverings and window shades it cost 19.1c. per cubic foot; with accessories, it cost 22c. per cubic foot.

The plans for the building were prepared in the department of public works, of which R. Keith Compton is director, by the bureau of surveys and design, of which James Bolton is chief. W. A. Childrey, assistant engineer of the bureau, designed the details of construction and coordinated the work of the several subcontractors, the department of public works acting as its own general contractor.

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Municipal Bond Sales Show Great Improvement

IMPROVEMENT in the market for city, county and state bonds has gone on at an increasing pace during March. The long list of sales here given comes down to Friday, March 18. Very few failures to sell have been reported That the improvement is expected to continue is shown by preannouncements of 32 offerings for the current week.

Besides bond orders the list includes the outcome of a few bond elections. Most governing bodies are still loath to put bond issues to popular vote, a hesitancy apparently justified by the considerable percentage of defeats reported.

Boston, Mass., March 16. Sold $1,000,000 $5\frac{1}{4}$s $6\frac{1}{2}$-month notes at par. In February sold notes at $5\frac{3}{4}$ per cent.

Newton, Mass., March 9. Reported city recently borrowed $100,000 at 5 per cent, the lowest rate obtained recently by any Massachusetts city; fourteen banks bid. On March 10 awarded $300,000, $4\frac{1}{4}$s, 1933-47 sanitarium bonds at 100.33; issue to be offered to individual purchasers to yield 4.1.

Greenwich, Conn., March 8. Purchaser will re-sell new issue of $400,000 public improvement bonds: $200,000 at 5 and $50,000 at $4\frac{1}{2}$, 1933-48, to yield $4\frac{1}{4}$ to 5; $150,000, $4\frac{1}{2}$, 1950-54, priced at $104.25.

Meriden, Conn., March 19. Award announced of $250,000 $4\frac{3}{4}$s 1934-43 bonds at 100.046; re-offered to yield 4.4 to 4.75.

New Britain, Conn. Unable during "some weeks" to sell $250,000 one-to-five-year notes to meet deficit in public welfare department, plan under consideration to sell $100,000 to $125,000 tax-anticipation notes to pay March bills; buyer in sight for $125,000 at 6 per cent.

New Haven, Conn., March 9. Sold $2,500,000 6s one-year tax-anticipation notes to dealers who offer to yield 5.

Nassau County, N. Y., March 15. At private sale, $3,550,000 $5\frac{3}{4}$s five-year tax-anticipation bonds at par to syndicate; re-offered to yield 5.2.

Port Chester, N. Y., March 19. Sold $185,000, 6s, at par to local bank; no other bidder.

Putnam County, N. Y., March 18. Purchaser re-offers $80,000 5s highway bonds, 1933-44, to yield 4.7 to 5.

Westchester County, N. Y., March 3. Sale announced of $1,375,000 6s certificates of indebtedness, of which $1,240,000, due June 5, 1932; remaining $135,000 one-to-three-year for unemployment relief.

Amsterdam, N. Y., March 3. Sold $236,000 $5\frac{1}{4}$s, 1933-42 public improvement-bonds at 100.06; put on resale to yield 4.75 to 5.35.

Babylon, N. Y., March 15. Village defeated $50,000 five-year refinancing bonds, 285 to 188.

Freeport, N. Y., March 18. Buyer of $278,000 $5\frac{1}{2}$s 1933-62 sewer bonds at 100.38 re-offers to yield $5\frac{1}{4}$ to $5\frac{1}{2}$.

Malvern, N. Y. Early in March defeated $525,000 school bonds.

Rochester sells $6,160,000

Rochester, N. Y., March 15. Sold $6,160,000 new issue bonds for various improvements to syndicate at $4\frac{1}{2}$, 5 and 6 per cent, according to maturities, at 100.111 to yield about 4.75; put on general market to yield 4.4 to 6. Another group bid above par.

Sea Cliff, N. Y., March 16. Village defeated $20,000 permanent road improvement bonds, 319 to 233.

Syracuse, N. Y., March 14. Purchaser of new issue $275,000 6s "bearer" notes, due Sept. 14 next with re-offer to yield 5.1.

Yonkers, N. Y., March 14. Awarded $2,500,000 bonds to syndicate at 100.29; $1,990,000 6s 1933-52 at 6, re-offered yield $5\frac{1}{4}$ to $5\frac{1}{2}$; $540,000 5s 1934-48, offered to yield 5.1 to 5.5.

Bergen County, N. J., March 17. $1,000,000 (temporary?) loan at 6 per from two New York banks.

Essex County, N. J., March 14. $1,401,000 6s five-year refunding bonds Newark and New York group, to be d April 1.

Hackensack, N. J., about March 19. $298,000, 6s, 1933-54; re-offered March to yield 5.5

Union County, N. J., about March sold $2,787,000 6s, 1937-38, to yield 5.5.

Denville, N. J., March 9. No bids $100,000 short-term water bonds to rede notes and provide funds for extensio although inquiries had been received fr eleven bond houses. Believed that $75,0 unpaid taxes last two years discourag bidders.

Linden, N. J., March 8. Council auth ized sale of $108,000 bonds to New Jer State Employees' Relievement system, yield 6.

Livingston, N. J., March 15. Voters d feated $80,000 school addition bond iss 198 to 125.

Paterson, N. J., Feb. 29. Sold $130, 6s "over counter." Another sale, Ma 14: buyer offers $258,000 $4\frac{1}{2}$s, 1955- water bonds to yield 5.75.

West Orange, N. J., March 14. Pu chasers offer $275,000 6s, 1932-38, to yi 5.5.

Fulton County, Ga., Feb. 27. Flo $1,000,000 $5\frac{1}{2}$s, due Dec. 31, 1932, wi agreement for $1,000,000 more, for curre expenses. About this time voters rati $700,000 school bonds, 10,243 to 1,400, f new buildings and extensions.

$15,000,000 of $35,000,000 sold by Louisiana

Louisiana, State of, March 14. One bi at par for $15,000,000 only of $35,000,0 5s, 1936-52, state highway bonds; bid a cepted.

Memphis, Tenn., March 8. Sale an nounced of $200,000 of $300,000 authoriz tax notes due May 1.

Louisville, Ky., March 17. Offered i Chicago market for resale $2,000,000, 4 1969 sewer bonds at 101.81, to yield 4.4.

Wayne County, Mich. Early in Marc defeated $258,000 sewer bonds.

Illinois, State, March 12. Slight oversubscription for $12,500,000, 6s emergenc relief bonds, offered through Chicago bank without profit.

Oshkosh, Wis., March 18. Purchaser of $250,000, 5s, 1938-42 sewer bonds (offered March 7) re-offers to yield 4.4.

Minneapolis, Minn., March 10. Sold at 100.11133 new issue $1,482,000, $4\frac{3}{4}$ water, permanent improvement and public relief bonds, mostly 1933-52; re-offered to yield 4.4 to 4.75.

South Dakota, State, March 3-5. Western bond houses take option on $2,000,000, $6\frac{1}{2}$ five-year rural credit refunding bonds; re-offered to yield 6.

Eight syndicates bid

Missouri, State, March 8. Eight syndicates bid on $2,500,000, $4\frac{3}{4}$s, 1948-50 bonds; awarded at 102.937; re-offered to yield 4.4.

Little Rock, Ark., March 5. Holders of $1,350,000 short-term notes issued July, 1931, by state construction commission have agreed to renewal on installment plan.

Hidalgo County, Tex., March 9. Plan agreed on to refinance tax warrants, post-due coupons and scrip at 2 to 5 per cent.

Denver, Colo., March 9. One-day "over-the counter" bond sales totalled $875,000 as $4\frac{1}{2}$ "less 1" at 94.6.

Seattle, Wash., March 16. Purchaser of $300,000, 5s, 1934-52 improvement bonds to re-offer to yield 4.75 to 5.

Oregon, State, March 3. No sale of $1,000,000, six-month highway bonds; decided to offer again March 16, bidders to name interest.

California, State, March 10. Sold at 100.657—$1,225,000, $4\frac{1}{2}$s, 1939-44 veteran welfare bonds for which no bids March 1; unsold part of $6,000,000 issue originally scheduled for sale Dec. 17, 1931.

Montpelier, Idaho. Recent defeat of $80,000 waterworks bonds at polls.

Manitoba, Province. March 8 sold $2,000,000, 6s, ten-year refunding at 97.5, to yield 6.35; largely oversubscribed.

Railway Engineers Discuss Practice and Economics

A.R.E.A. in short but comprehensive meeting considers 27 committee reports—Revisions of specifications adopted for the Manual

Engineering News-Record Staff Report

FOR the second time, the annual convention of the American Railway Engineering Association was condensed to a two-day meeting, with five sessions, on account of the business depression. For the first time the usual exhibit of railway appliances was eliminated, for the same reason. At this 33d convention, held in Chicago on March 15 and 16, the secretary's report showed a membership of 2,723, with 110 new members and 178 lost, or a net decrease of 68 for the year. The total attendance was 757, of whom 643 were members, as against 975 with 746 members in 1931. The elimination of the exhibit accounted for a large reduction in the number of visitors. Of 29 committees, 27 made reports, all of which were printed in advance and aggregated about 600 pages, a little less than last year. Officers elected for 1932-33 include: president, J. V. Neubert, chief engineer, maintenance-of-way, New York Central Lines, New York; vice-presidents, W. P. Wiltsee, chief engineer, Norfolk & Western Ry., and J. E. Armstrong, assistant chief engineer, Canadian Pacific Ry.; secretary (reelected), E. H. Fritch, Chicago.

Constructive discussion of the reports was of small amount, as usual, but a little controversial discussion arose over conflicting specifications for concrete as prepared by two separate committees. The large number of reports probably has some influence in checking discussion, but the general attitude seems to be that matter submitted as information need not be discussed and that matter submitted for the Manual has been so well prepared by the committees that it might as well be accepted. Unfortunately, presiding officers rarely attempt to overcome this inertia by inviting or requesting discussion on particular subjects or by calling on individual members.

Words from the I.C.C.

An address by C. R. Porter, chairman of the Interstate Commerce Commission, was given at a luncheon held during the noon recess on March 16, the usual evening banquet being omitted. After outlining the new transportation conditions due to developments in the use of trucks, buses, waterways, pipe lines and airways as competitors of the railways, Mr. Porter urged uniform regulation to insure equality of treatment and to prevent discrimination. He advocated consolidation in order to form a limited number of large and financially sound systems, able to withstand depression periods and to provide more efficient service. As to passenger traffic, he thought there were opportunities to offer real bargains in rates and service that would attract passengers from other methods of transportation. In his opinion the railways should be granted greater freedom in dealing with other forms of transportation, with joint rates and through rates. Repeal of the "recapture clause" in the transportation act he considered a vital necessity to restore the credit of the railroads, by enabling them to hold and use their profits and therefore encouraging them to make larger profits. Finally, he considered that the Interstate Commerce Commission should adopt a much more stringent policy as to new construction, preventing roads from entering territory already well provided with railway communication. On the other hand, the commission should be less stringent as to requiring roads to continue the operation of branch lines which show a substantial loss and are thus a heavy financial burden on the main lines or the system as a whole.

Rail investigations

Progress on the rail studies arranged by cooperation of the American Railway Association and the rail manufacturers, as announced at the 1931 meeting, was reported by the committee on rails. This program is for five years, at $50,000 a year, financed jointly. Already 5,000 tons of 130-lb. and 5,000 tons of 110-lb. rails have been ordered, each order divided among four mills and the rails to be laid on different roads. Specimen rails will be sent to the University of Illinois for study, and close record will be kept of manufacture, service and performance. An outline of the university's share in the work was given by Prof. Moore, while A. N. Talbot presented a review of the rail and joint investigations of the committee on stresses in track. These include 130-lb. rails with 39-in. splice bars on the Chesapeake & Ohio, and 110-lb. rails with bolt fastenings on the Missouri Pacific.

Failures of rails rolled in 1925 were reported as 110.7 per 100 miles of track in 1930, the same as for the 1924 rails in 1929; in fact, the average for five years' service has been substantially constant for the rollings of 1922 to 1925, inclusive. Transverse fissure failures numbered 6,711 in 1930, an increase of 473 over 1929 and making an accumulated total of 50,746. The increase for 1930 was due largely to wider use of methods for locating the fissures before actual failure occurs. The Sperry detector car of the American Railway Association has been rebuilt for heavier work. From November, 1928, to November, 1931, it had tested 11,133 track miles, detecting 988 fissured rails and 3,453 defective rails of all kinds. The average was one fissure rail per 11.3 miles and one defective rail per 3.2 miles.

Bridges and trestles

A conclusion to the effect that results of experience and service tests show the rust-resisting value of copper-bearing steel, with a recommendation for its use in railway structures exposed to corrosive influences, was the only important subject presented by the committee on iron and steel structures. But the committee on standardization outlined the controversy over the separate specifications for steel bridges submitted to the American Standards Association by the A.R.E.A. and the A.S.C.E. To harmonize the differences and produce a single specification for approval as "standard," a joint committee was appointed in 1925 and submitted its specifications in March, 1929. The A.R.E.A. committee on iron and steel structures did not accept these and in July, 1931, it withdrew the A.R.E.A. specifications originally submitted.

Little progress has been made in getting railways to adopt the association's standard designs of timber trestles, according to the committee on wooden bridges and trestles. Such use is highly desirable in simplifying the manufacture of bridge timbers and thus reducing the number of sizes now necessarily kept in stock. Comparison of relative merits of trestles of concrete and treated timber is impracticable at this time, according to the committee, because of lack of reliable data on maintenance cost and the difficulty of predicting average life for long-lived structures, the oldest of which have been in use for perhaps less than half their average life.

Concrete slab floors for highway bridges over track were reported as preferable to laminated floor construction with asphalt plank wearing surface. Studies of piledriving formulas indicate that the *Engineering News* formula is satisfactory and that there is no necessity for attempting to devise any new formula. The actual effective net energy in forcing the pile down is difficult to determine, especially with concrete piles, owing to the varying design of the cushion which is used to protect the head of the pile and which absorbs some of the initial striking energy. However, it was considered that the hammer should be as heavy as it is possible to use without damage to a pile properly cushioned. Its rated gross energy in foot-pounds should be twice the weight of the pile for average driving conditions, once or twice the weight for soft driving and two or three times the weight for hard driving.

Operating economies

That increased traffic capacity may be obtained by more intensive use of existing facilities was outlined in conclusions of a report of the committee on economics of railway operation, which was adopted for the Manual. Such intensive use may include better supervision, increased capacity of locomotives, larger tenders to eliminate stops for water, double tracking, automatic signals on single track and controlling train movements by signals instead or by train orders and timetables. This last method was presented in some detail by the committee on signals and interlocking. An unusual subject studied by the committee on economics of railway operation was the possible economy of converting double track to single track when traffic decreases. This plan has been carried out to a considerable extent in Ireland, but no mention of this was made in the report and undoubtedly the conditions there were exceptional.

Yards and grade crossings

That design and operation of freight yards is developing along scientific lines was indicated by extensive changes in the matter now in the Manual relative to hump yards. These changes, largely due to increased use of car retarders, were adopted as submitted by the committee on yards and terminals. The typical hump profile, for retarder yards, has a 4 per cent starting grade, followed by 2½ per cent to the first switch and 1.66 and 1.85 per cent on the leads which serve the body tracks, the old ladder track layout being eliminated.

Typical parking space layouts for passengers' automobiles at railway stations were submitted, together with a report on the design and necessary facilities of large produce terminals. With the heavy modern loads on track scales, special attention is needed in the design of the knife edges which transmit the loads. Reference was made to a study at the University of Illinois as to the shape and hardness of scale pivots and bearings.

Another indication of overlapping subjects was the request of this committee that the main part of its rail-and-water terminal assignment (covering piers and docks) should be transferred to the committee on rivers and harbors, which is already handling the subject. This will leave to the former the logical features of industrial development and rail terminal facilities.

The undesirable feature of net increase in number of grade crossings was noted by the committee on grade crossings, whose report referred to the erroneous local idea that each crossing is a convenience or a local asset. With the speeds of automobiles, short detours from one road or street to another to reach a crossing are no hindrance to traffic. A proposed form for classifying crossings and recording traffic was adopted after some modifications had been made. Instead of requiring this record to be made for every crossing, as proposed, it is to be used only where desired, since a large proportion of crossings are not really needed. The form provides for statements as to whether the crossing may be eliminated by relocating or closing the highway or by separation of grades. An appendix described the Detroit system of studying grade crossings by regions or districts rather than as single units.

Masonry and buildings

Trouble developed when the committee on buildings submitted for the Manual a set of specifications for concrete for buildings; these had been presented a year ago. But the committee on masonry pointed out that its own specifications are now in the Manual and that the new ones differ in certain respects, so that there would be the unfortunate feature of recommending two different specifications for the same material. In the somewhat long and warm discussion the blame was laid partly on the board of direction (or its committee on subjects) for lack of judgment in assigning the matter in such a way as to lead to duplication and overlapping. A conference committee was suggested to settle the differences and the specifications were not adopted. The committee on buildings also submitted specifications for steel, brick and concrete chimneys. In a review of trainsheds it classified the lofty arch type as obsolete, superseded by the low continuous roof; but the high cost of the latter limits it to important passenger terminals. Of platform shelters, the buterfly type was considered preferable to the umbrella type.

Some minor changes in the present concrete specifications were adopted at the request of the committee on masonry, particularly in changing the maximum size of coarse aggregate from four-fifths of the minimum clear space between bars or mesh to "half" this space and "one-fourth" the least dimension of the member. Tests for soundness of concrete aggregates and specifications for repairs to deteriorating concrete were submitted as information. It was suggested in discussion that when concrete shows disintegration it should not be repaired as maintenance work, but studied by the engineering department before any work is undertaken.

A review of methods of lining and relining tunnels indicated that concrete is generally used in this country, while brick, stone and concrete are used abroad. This review included the lining, packing, drainage timbering, placing of concrete, disintegration of concrete and effect of engine blast.

The Huntington locomotive repair shop of the Chesapeake & Ohio, designed and laid out on the basis of a time study of machine tool and erecting shop operations, was described by the committee on shops and locomotive terminals. This committee also reported that car repair shops can readily be adapted for handling automotive railcars and multiple-unit cars. For electric locomotives, new repair shops are considered to be more satisfactory and economical than altering old shops built for serving steam locomotives.

In the utilization of air rights over railroad property, title for air-right buildings is mainly in the form of long-term leases, according to the committee on uniform general contract forms. It is expected, however, that the alternative method of conveyance by deed will increase rapidly.

Labor economics

Changes in maintenance organization due to heavier track construction and rapidly increasing use of machinery have resulted in important economies, according to the committee on economics of railway labor. An analysis of man-hours of track labor on the Lehigh Valley shows a reduction of about 50 per cent from 1918 to 1930, due to the above and other factors. Several roads are now having nearly all maintenance done by floating gangs equipped with modern machinery instead of by section gangs, the latter having little more than inspection and minor repair jobs during the working season. These maintenance gangs are independent of the usual extra gangs for such work as rail renewal and ballasting. The committee considers that this new development promises large economies. It also approved of spray painting as satisfactory and economical, this conclusion being adopted for the Manual, while spray-painting equipment was dealt with in another report.

Along similar lines was the first report of the new committee on maintenance-of-way equipment, which showed the effective and economical use of compressed-air and electric tools and equipment, thus increasing the output per man. Power dragline excavators on crawlers were shown to be adaptable for ditching, grading, widening cuts and handling materials in general railroad work. Oil-spraying machines for rails and fastenings and for dusty ballast and roadbed, as well as modern developments in ballast-cleaning machines, were also covered by this committee.

Ties and track

Increased use of the A.R.E.A. standard specifications and better practice in stacking ties for seasoning was reported by the committee on ties. Possible economies by the use of longer ties, 8½ and 9 ft., instead of 8 ft., giving increased bearing area, were noted and are under study. Evidently increased length must be accompanied by increased sectional dimensions. As to substitute ties, removal of steel ties continues (with no replacements), while a detailed report on the numerous concrete ties installed by the Pennsylvania shows large numbers of cracked, disintegrated, crushed and broken ties. From this and previous reports it appears that the substitute tie is quite out of the picture as a factor in track construction in this country. On the other hand, the service tests reported by the committee on wood preservation showed, as usual, the long life and high economies of treated wood ties. This committee opposed as uneconomical any modifying of the specifications to admit ties with slight decay for treatment.

Tests of shrinkage of ballast undertaken by the committee on ballast have been halted by inability to induce railroads to establish a sufficient number of test sections for observation. Records were given for seven installations, which in 30 months showed 18 to 42 per cent shrinkage. Only one road could be found having detailed figures for cost of maintaining track on different kinds of ballast. As to sub-ballast, a change in the Manual was adopted, recommending (instead of equal thickness) 18 to 6 in. of sub-ballast and 6 to 18 in. of top ballast, according to volume of traffic and character a roadbed.

A group of revised plans of switches and frogs submitted for the Manual by the committee on track, was adopted. A final report on flangeway and gage at frogs and crossings recommended a minimum flangeway width of 1⅝ in., with minimum track gage of 4 ft. 8¼ in. The standard width is 1¾ in., but with manganese frogs the tendency is to close in, many being found with 1⅝ in. or less, so that 1⅞ in. may be considered good practice.

Experiments with permanent roadbed construction do not increase, but the roadway committee reported the present situation with concrete slab construction (under the ballast) on a few roads, and the concrete substructure of the Pere Marquette in which the rails are laid directly on the concrete (except for a felt cushion). In this latter case, battering of the rail ends is more pronounced than on ballasted track. Other work of this committee adopted for the Manual included the maintenance of heaving track, specifications for pipeline crossings under tracks, sub-surface drainage, overhaul in grading and the protection of roadbed and bridges from washouts and floods. This last subject applies only to non-navigable streams, thus avoiding interference with the committee on rivers and harbors. The committee's revised specifications for concrete fence posts were adopted, after some objection to the short curing period at high temperature and to the omission of a time limit for removal of forms.

Miscellaneous

New methods of water analysis, submitted by the committee on water service and sanitation, were adopted as being more accurate and adequate than the matter now in the Manual. They include specifications for salt used in the regeneration of zeolite water-softening plants. Water treatment at small plants, the blowing down and washing out of boilers and the use of coagulants in treating boiler water were other subjects discussed. It is considered that the additional cost due to using coagulants is justified by the results. Tests on the use of corrosion-resisting materials in railway electrical construction, noted by the committee on electricity, are being made at tunnels, engine houses and piers in seawater.

Specifications for riverbank protection, submitted last year by the committee on rivers and harbors, were adopted for the Manual. Specification of the U. S. Engineers for hydraulic levee construction, mattresses and fascines were presented as information, together with reports on jetties, seawalls, wharf fenders and pier construction.

Instructions for engineering field parties were adopted, being presented by the committee on rules and organization to replace the present material in the Manual. Formal instructions for bridge maintenance and fire protection were also adopted. A form of agreement for the purchase of electric energy, submitted by the committee on uniform general contract forms, was objected to on the score of unnecessary verbosity, but as it was a progress report no action was taken. A form of agreement for joint passenger stations was adopted.

Methods used in recapture proceedings and the Interstate Commerce Commission's order on depreciation were presented by the committee on records and accounts. As to simplifying work with respect to the commission's requirements on accounting, valuation and depreciation, the committee pointed out that duplication results partly from the commission's having separate bureaus of valuation and accounting. However, no improvement can be expected until the railroads organize among themselves, adopt uniform or standard methods and act as a unit in dealing with the commission. At present the railroads cause duplication and prevent simplification by their own diverse methods.

Letters to the Editor

Labor's Share of Relief Funds

Sir—The letter of F. B. Cobb, of Chicopee Falls, Mass. (*ENR*, March 10, 1932, p. 376), contains a point of view deserving discussion.

Mr. Cobb notes that of $800,000 raised and spent in Chicopee Falls for public works, only about $200,000 went to labor in Chicopee Falls; the rest went out of the town for materials, machinery, etc. As the appropriation for public works had been made largely for relief during the depression, the thought arose that such a project must be a failure, for, according to Mr. Cobb, less than 25 per cent of Chicopee Falls money went to Chicopee Falls citizens. I imagine this experience has been rather common.

But was the $600,000 wasted as far as relieving the depression was concerned? Of course not! The percentage of money to labor does not vary so widely throughout industry. The 25 per cent may seem low for putting the materials together to form roads and bridges, but I doubt if the cement used represents more than 50c. out of the dollar for labor in the cement mill. A few cents, at this point, went to management and overhead, the rest to materials such as oil, bags and fuel. We could chase each of these items down and study the way each dollar was split at each stage between labor and capital, and how much was represented by raw or partly finished materials. If we should add up all of the amounts that went to labor, we should find that nearly $600,000 of that $800,000 went to "immediate" labor located in a large number of different places in the country, and the rest went in various ways to capital. If the public works had not been undertaken by Chicopee Falls, business elsewhere would have been worse.

At first glance Chicopee Falls is not interested in "elsewhere." But is this true? Mr. Cobb must tell me, first, how much of the money that left town came back to other industries in Chicopee Falls. If the money had not been spent, less goods would have been sold by industries in Chicopee Falls and numerous other places. And so it is for town after town as well as industry after industry that has spent money during the depression. It is difficult to trace the devious pathways of the dollars spent, but we do know that $600,000 went to improve conditions throughout the country through the efforts of this one town. Judging by the frenzied actions of legislators from Connecticut, Massachusetts and many other places, money spent outside of one's own state is wasted. But unless each state is to follow the "family" type of economy and produce everything at home, money and goods must pass state borders freely. Business is not helped by living unto one's self.

Chicopee Falls may not be able to afford to continue this lavish spending, however worthy the aim. Mr. Cobb must consider how far his city may go in such relief. Perhaps conditions outside his control may force direct relief rather than public works. Perhaps it would be better to extend credit to local industry. That is one side of the question.

But the other is fundamental, and the continuance or disappearance of this depression rests upon the action taken. Suppose I should go out tomorrow and order all the things I need to replace worn-out clothes, obsolete cars; bring my library up-to-date; perchance marry a certain young lady; carry on certain research work; in fact, act as though the clouds had passed by. Sounds foolish, doesn't it?

If a very large number of other people should do the same thing, every factory would have orders on its books requiring work at very good capacity for a year. It would be necessary for most of us to go back to work on a nearly full-time basis. When the year had passed on we should find, much to our surprise perhaps, that we had paid for the goods we had ordered with such rash abandon. Unfortunately, there is no immediate prospect of any such group of people getting together and deciding to act in this fashion. There is no real excuse for the continuation of the depression; yet, lacking cooperation and understanding, there is no immediate prospect of anything except starvation, want, perhaps riots and widespread social disturbances. We hear about the tightness of credit, the depreciation in securities values, the necessity for raising tax rates. Yet, however real the present disturbance, effectively it is something unreal, imaginary and unnecessary. If we should be able to get together and decide to go to work, and on the basis of that understanding place orders for the things we are able to afford—given stability, the depression would be over and values would return to normal. We should be left somewhat handicapped with debts, and other unpleasant details would remain for some time to remind us of our folly.

How does this concern Mr. Cobb and Chicopee Falls? As it concerns every other city and industry and person. Either we act in unison to return to normal, or we act separately, looking after our individual selfish interests and continuing to suffer. The continuance of the spending by Chicopee Falls impoverishes Chicopee Falls citizens unless every other town and state, individual and industry does its share to act for the general welfare. And in the end the general welfare is very distinctly our own. If business and credit continue to dry up, Mr. Cobb and Chicopee Falls must cut down on expenditures. They cannot live more fully than the rest of the country. But the prime duty of Mr. Cobb, Chicopee Falls and the rest of us is to find ways and means of getting together on this proposition of spending money, Mr. Cobb and Chicopee Falls typify the country and the world. They cannot live to themselves. That way lies disaster.

A conference of big business men, large cities, the government and the states, at which the business of those present would be to lay down a spending program for those things needed for the next year *on the basis of nearly normal business* and the adoption of a definite program, however imperfect, would at once force a general upturn. Common action by a few of our largest spenders would soon be followed by general action elsewhere. Credit would loosen up; it merely requires the definite promise of business. The details would almost arrange themselves. The important thing is to get the people back to work in large measure. The method suggested is probably the simplest that can be devised.

These, then, are the thoughts suggested by the letter of Mr. Cobb. That there is a large amount of need cannot be denied. It will take several years of work to begin to satisfy it. Let us go!

EDWARD ADAMS RICHARDSON.

Bethlehem, Pa.,
March 17, 1932.

Is Engineering Local?

Sir—In *Engineering News-Record*, March 10, p. 347, on the editorial page under the heading "Is Engineering Local?" there is an editorial commenting upon the action of the Western Society of Engineers relative to House Bill 6187. This editorial is manifestly unfair, and the inferences drawn are not warranted—in fact, they are not in accordance with the action of the society in any wise.

I am inclosing our March 2, 1932, *Bulletin* in which the announced action of the society is indicated. It was in the form of a telegram sent to the chairman of the House Committee on Public Buildings and Grounds so as to reach the committee on the occasion of its hearing on the bill.

As drawn, the bill required that the engineering and architectural consulting service be engaged from the locality in which the buildings are to be erected. We offered the suggestion that the immediate locality might not produce competent service, and therefore this limitation should not preclude the engagement of competent service from outside such locality.

May I suggest that if *Engineering News-Record* wishes to comment upon any action of the society, it publish the action so that the readers can understand themselves what was done. In this instance I think that a public correction is due us, and I shall leave the matter in your hands for proper action.

EDGAR S. NETHERCUT,
Chicago, Ill., Director
March 17, 1932. Western Society of Engineers.

EDITOR'S NOTE—The telegram referred to reads as follows:

> Board of Direction, Western Society of Engineers, supports House Bill 6187 in principle. We suggest inclusion of provision that if no competent engineer or architect be located in a locality, the nearest locality with proper talent be considered in selecting consulting service.

The title of the article in the Western Society *Bulletin* is "Board Urges U. S. to Employ Local Engineers," and the statement preceding the above telegram reads as follows:

> The Board of Direction voted to support this bill and authorized the secretary to send the following telegram to the chairman of House Committee on Public Buildings and Grounds.

First Skyscraper Again

Sir—Under the heading "Wrecking Home Insurance Building Reveals Excellence of Old Metals," Henry Penn states: "This early skyscraper, now declared by a board of investigating architects to have been the first skeleton-frame building, yielded its place not because of physical deterioration but because it could no longer produce the necessary revenue."

In this article the editor quotes from an article by Henry J. Burt in *Engineering News-Record* of April 17, 1924, referring to the Home Insurance Building, the words, "near approach" to skeleton-frame building and also the words "true skeleton" construction as applied to the Tacoma Building.

These four words separated from their context in the original article might be construed as a statement which the context would hardly bear out. Likewise, the reference to the board of investigating architects referred to by Mr. Penn in the article, which was written quite some time ago but only recently published, might be considered authoritative. Such quotation may lead to erroneous conclusions.

The editor also refers in brief to the investigating committee of the Western Society of Engineers and quotes the portion of this report which has to do with the individual responsibility of developing the skeleton construction. The report of that committee was later than the references mentioned above, the committee feeling that it desired time to assemble as completely as possible all the information necessary to render an opinion. This report includes a simple but complete definition of the term "skeleton construction." The report then proceeds to compare the Home Insurance Building design with this definition. Likewise, the Tacoma Building construction is compared with this definition. The report, from the February, 1932, *Journal* of the Western Society of Engineers, is attached.

Attention should be called to the Rand-McNally Building, erected in 1890, which stood on the south side of Adams St. between La Salle and Wells Sts. This building was probably the first skeleton construction involving all the principles outlined by the report of the committee of the Western Society of Engineers. The columns were of steel, Z-bars being used.

EDGAR S. NETHERCUT,
Director, Western Society of Engineers.
Chicago, Ill.,
Feb. 26, 1932.

EDITOR'S NOTE—The report, dated Dec. 29, 1931, was prepared by J. C. Sanderson, J. L. McConnell, and F. J. Thielbar. The following abstract covers the parts concerned with the question of priority as between the Home Insurance and the Tacoma buildings.

The Home Insurance Building was constructed at two different dates. The first section consisting of nine stories (1884) was constructed of cast-iron columns, with cast lugs on the columns to support cast-iron lintels and steel or iron beams. These columns were placed in all pilasters and supported the interior floor construction, certain spandrel beams and cast-iron lintels. The spandrel beams being located at the third, fifth, and eighth floor levels and at the roof level, it will be noted that these spandrels supported two and three floors of masonry walls.

The walls of the building varied in thickness from 24 and 30 in. at the first floor to 12 in. for the top floors and were of sufficient thickness to be self-supporting without the use of columns in the pilasters.

As this building was constructed during the development period of the skeleton building it will be interesting to compare it with the typical skeleton building as now constructed. Supporting masonry by the use of structural members was not novel at the time this building was erected, nor was the supporting of loads with a combination of masonry and structural columns. Lintels were common practice, as was the supporting of store fronts by a combination of lintels and columns.

The Home Insurance Building complies with or diverges from the essentials of a steel-skeleton building as follows (only the two street walls being considered):

1. The steel skeleton was self-supporting.

2. Structural members were provided for supporting the masonry, but on account of the size of the piers it is probable the load was divided between the columns and the piers.

3. The wind load was carried by the masonry, as the steelwork was not designed to take wind bending.

4. The masonry work could not be started at an upper floor without providing temporary support for the 8 in. of masonry in front of the cast-iron columns.

5. The walls were not of the curtain type but were, as previously described, of the ordinary bearing type. It is apparent that the designer of this building was reluctant to give up the known strength and security of heavy masonry walls and piers for the untried curtain walls and steel windbracing of the modern skeleton building.

The Home Insurance Building carried the floor loads on the structural frame, supported masonry walls on the structural frame, probably assisted by the many piers, made no provision for wind load in the structural frame, did not fully provide for starting masonry above the first floor and did not have curtain walls.

The Tacoma Building, built in 1887 at the northeast corner of La Salle and Madison Sts., did not carry all floor loads on the structural frame, supported the masonry walls on the structural frame, made no provision for wind load in the structural frame, fully provided for starting the masonry walls at any floor and had uniform curtain walls.

In the transition from the bearing-wall building to the skeleton type the Home Insurance Building made a marked advancement. The Tacoma Building went a step farther, improving some of the details, adding curtain walls and making full provision for starting the masonry at any floor level.

Cement-Water Ratio by Weight

Sir—In *Engineering News-Record* of Feb. 11, Professor Mavis criticizes my article, "Cement-Water Ratio by Weight Proposed for Designing Concrete Mixes" (*ENR*, Nov. 5, 1931), pointing out that the water-cement-strength relation will give a straight line when plotted on semi-logarithmic paper. This fact has long been realized, since the Portland Cement Association derived the formulas for the water-cement-strength relations by means of straight lines on semi-logarithmic paper. The necessity of the semi-logarithmic graph paper is a very good illustration of the cumbersome procedure that has to be followed when the equation for the water-cement-strength relation is desired. On the other hand, the equation for the cement-water-strength relation is derived directly from the plottings on ordinary graph paper.

The important part of my article was not the straight-line cement-water relation but the recognition of the fact that the cement is the strength-giving element in concrete. Professor Mavis criticizes also the important statement of the fundamental relation between the strength and cement concentration of a concrete mix. In concrete of a given type and gradation of aggregates the water content per unit of concrete of a given consistency remains constant regardless of richness of mix. The variable factor is thus the cement, and the only change in the cement paste caused by a change in the richness of the mix is the change in the concentration of cement particles in the constant amount of water. An illustration of the simplification that is made possible in the design of concrete mixes by the recognition of these fundamental principles is given in my second published article (*ENR*, Feb. 18, 1932, p. 248).

Professor Mavis states that the expression of gallons of water per sack of cement is most understandable for the inexperienced man. As a matter of fact, the same units may be used with the cement-water ratio. It is a matter of choice to use pounds of cement per pound of water, pounds of cement per gallon of water, sacks cement per gallon of water, sacks cement per cubic foot of water, sacks cement per barrel of water, etc. The all-important thing is the fundamental relation between the concentration of cement particles in a unit of water and the quality of the concrete having this cement paste.

The writer also appreciates the discussions offered by Messrs Smith and Kitts (*ENR*, Feb. 25 and March 3). Both of them agree to the nearly straight-line portion of the strength-cement-water relation for concretes within practical ranges. Below a certain minimum cement content per unit of water the straight-line relation cannot be expected to hold, for the simple reason that the amount of cement is not sufficient to prevent the segregation of water from the paste. In this case the actual cement-water ratio of the paste becomes greater than the ratio used in the mix. If, on the other hand, the amount of cement per unit of water is so large that each particle will have a lack of water for chemical reactions, the full potential strength of the cement cannot be utilized, and the strength will cease to increase in direct proportion to the increase in concentration of cement particles in the paste. Thus the straight-line relation between the strength and the cement-water relation of concrete holds only for the range within which the full potential strength of the cement may be utilized. Fortunately all plastic and workable concrete mixes used in present-day construction fall within the straight-line section of the relationship.

Mr. Kitts favors the use of absolute-volume ratios instead of weight ratios. The author cannot see any advantage in this proposal, which was originally developed by Feret in the 1890's and has since been used by many concrete investigators. The absolute volume is an abstract measure, and in order to utilize this measure in concrete mixes it has to be transferred into weights by use of the specific gravity. Why complicate matters by the use of the abstract absolute volumes when the weights have to be resorted to in order to measure the quantities of materials for the concrete?

The general approval given to the proposed cement-water relation is demonstrated by the number of favorable comments received by the writer from many of the most outstanding authorities in concrete, both in this country and abroad.

INGE LYSE,
Research Assistant Professor
of Engineering Materials,
Lehigh University.
Bethlehem, Pa.,
March 14, 1932.

NEWS OF THE WEEK

California Wage Law Is Questioned in Two Court Suits

THE extent of authority and the enforcement of the provisions of the California prevailing-wage law passed by the 1931 legislature have been questioned in two suits filed in the state courts involving major construction projects in southern California.

The city of Pasadena contends that it is a corporate entity by state charter and that the interference in its contractual relations caused by this act violates the home-rule principle and the city's right to freedom of contract. Construction of the $10,000,000 Pine Canyon dam is being held up pending the court decision on this question.

The Metropolitan Water District has attacked the constitutionality of the act on the ground that its Colorado aqueduct project will extend over such a large area and will continue for such a period of years that an attempt to establish a prevailing wage at the beginning of the construction places too great responsibility on the district and the contractor. For example, one of the first contracts to be let by the district would be for driving the longer tunnel units, involving about a five-year construction period, and the establishment of a wage at this time for such a contract would involve too many uncertainties, it is contended.

◆

Bids to Operate New York's New Subway Called for April 24

Forms for the contract for operating New York's new municipally built Eighth Ave. subway were approved by the board of estimate on March 19 and subsequently the board of transportation set April 26 as the final date for filing bids. The form of contract to be used was made available on March 24 at the time of the first official call for bids.

◆

$1,353,000,000 Road Program for State and Local Agencies

Funds estimated as available for public road and bridge construction and maintenance in 1932 amount to $1,353,000,000, according to information collected from road officials by the U. S. Bureau of Public Roads. Of this amount $882,000,000 is the probable expenditure by state highway departments, and $471,000,000, it is expected, will be spent by local authorities.

The detailed total of road and bridge expenditures in 1931 is not yet known, but the 1932 program is less by 19 per cent than the total rural road expenditure of $1,680,000,000 in 1930. Comparing state highway expenditures of $980,000,000 in 1930 with similar funds available for 1932, there is a decrease of 10 per cent. Similarly there is a decrease of 33 per cent in local funds, the 1930 expenditure having been $700,000,000.

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Sydney Harbor Bridge Is Formally Opened

On March 16 the builders of the Sydney harbor bridge turned the structure over to the New South Wales government and on March 19 it was formally opened to traffic. This steel-arch bridge, 1,650 ft. span, was built under the direction of J. J. C. Bradfield, chief engineer, Sydney Harbor Commission, by Dorman, Long & Co., of London, to whom the contract for fabricating and erecting the steelwork of the arch and the approach spans was let in March, 1924. The work of erection was described in *ENR*, Oct. 23, 1930, p. 646.

The bridge is the largest steel arch yet built, but lacks about 2 ft. of equaling the span length of the Kill van Kull bridge in New York. About 37,000 tons of steel (main members silicon steel) was used in the arch. The deck carries a 56-ft. vehicle roadway, four lines of rapid-transit railway tracks and two 10-ft. sidewalks. The bridge has a vertical clearance of 172 ft.

Prequalification Is Adopted for Bidders In Two More States

PREQUALIFICATION requirements for contractors on state highway work in Wyoming were adopted by the highway commissioners of that state on March 15 in accordance with the state law. All persons proposing to bid on state highway work estimated to cost more than $2,000 must furnish a statement under oath in response to a questionnaire to be submitted by the state highway department. Such statement shall fully develop the financial ability, adequacy of plant and equipment, organization and prior experience and such other pertinent and material facts as may be desirable, and shall be submitted every twelve months, or as often as may be required by the commission. No bid will be considered from a contractor unless he shall have submitted his statement prior to twenty days before a letting. Upon receipt

(Continued on page 449)

Oregon Abandons Hand Labor in Remainder of 1932 Highway Program

A CUT of 20 per cent in the $1,500,000 administratve payroll of the Oregon state highway commission, abandonment of the $72,000 a week outlay for hand labor for unemployment relief, and the prospect of spending $4,500,000 in new construction and major betterment on the roads of the state constitute the principal features of the program of the new state highway commission. (See *ENR*, March 10, 1932, p. 379.) One of the first acts of the new commission was to make salary cuts ranging from 10 to 20 per cent for the administrative personnel and to make certain reductions in personnel. In this connection the resignation of Roy A. Klein, state highway engineer, was accepted early in March, but Mr. Klein will be retained in an advisory capacity until May 1. He is succeeded by R. H. Baldock, formerly chief assistant engineer.

Lack of efficiency in the expenditure of $10,000 a day on hand labor as a part of the state's unemployment relief program and the fact that no federal-aid money could be secured for the projects carried on in this fashion, coupled with a temporary shortage in funds immediately available to the commission, led to the decision to cease this expenditure and to apply available funds by letting the work out on contracts in the usual manner. It is estimated that the cost of a mile of road by hand labor, if let under the contract method with federal money available under such circumstances, would build 8 miles of road, and the commission has felt that this is too high a price to pay for carrying on its relief of the unemployment situation by hand labor. The work that has been conducted in this manner, through which $1,250,000 has been expended since Nov. 14, will be tapered off through April until it entirely disappears, and from that time on all highway work will be conducted by the regular contract method.

For immediate cash requirements during the next six months the commission offered $1,000,000 worth of state highway bonds on which no bids were received. Portland banks filled the breach by taking $750,000 of this issue at 6 per cent with a six months' maturity and other local investors subscribed for $73,000, which is sufficient to meet the immediate needs of the commission. Among these needs are the retirement of $1,000,000 of the $30,000,000 long-term bonded debt plus $616,000 interest. A large percentage of state funds for highway work comes from automobile licenses, which are payable on July 1, hence the stringency is only temporary.

During 1932 the highway program will proceed practically as outlined last year and includes the expenditure of $4,500,000 for new construction and major betterment, made up of $2,400,000 state money and $1,600,000 federal aid. This does not include the possible $2,000,000 of federal money for Oregon provided in bills now pending before Congress. The budget also provides an expenditure of $1,300,000 on secondary roads. These items, with the $1,000,000 already expended in 1932 on relief work, will make the 1932 program slightly greater than the program of 1931.

Prequalification Is Adopted

(Continued from page 448)

of a statement in response to the questionnaire the state highway superintendent will examine the information therein and will then classify the prospective bidder or reject him as unqualified. A rejected applicant may request a hearing before the state highway commission. Prospective bidders will be classified as general contractor, grading contractor, surfacing contractor or bridge contractor. Each bidder must file with his bid a statement of contracts in force and contracts entered into subsequent to the filing of his annual questionnaire. He must also file a plan and equipment questionnaire with each bid.

Requirements in California

The division of highways of the California state department of public works has adopted a policy with reference to statements of experience and financial condition filed by contractors desiring prequalification for highway work, requiring a certificate of a certified public accountant in all cases where the contractor desires to qualify for work in excess of $50,000. New statements will be required only once each year unless specifically requested at more frequent intervals. When the financial information becomes a year old, if a new statement has not been submitted, the contractor will be disqualified from further bidding until a statement has been received and a new rating established.

Two or more contractors who have qualified by filing separate statements and who wish to combine their assets for bidding on a single project may do so by filing an affidavit of joint venture.

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Contract Information Bureau Issues List of Contractors

The Bureau of Contract Information, Inc., has published a list of nearly 5,000 contractors who have voluntarily filed performance records with the bureau. This list is available to architects, engineers and public officials who award construction contracts. The bureau issues performance records on contractors without charge to those responsible for the award of contracts, asking in return information concerning contractors with which they have had experience. In addition to the contractors listed, the bureau has records of many more, obtained by special investigation after a request has been made concerning a contractor who has not filed his performance reports. The new address of the Bureau of Contract Information is 729 Fifteenth St., N.W., Washington, D. C.

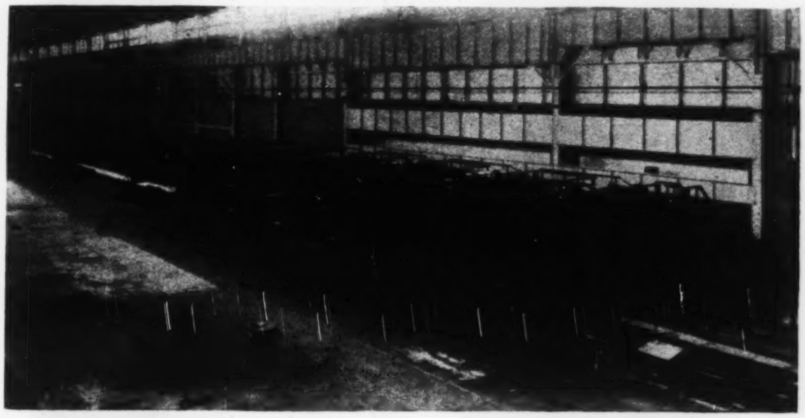
◆

Building Permits Show Drop From Similar Period Last Year

Building permits for the country fell off 54 per cent in January and 56 per cent in February from similar periods last year, according to reports from 50 representative cities used as a barometer for the entire country. The 50 cities used in compiling the estimate were listed in *ENR*, Feb. 4, 1932, p. 165, except that Manchester, N. H., has been substituted for Burlington, Vt., and Great Falls, Mont., has been substituted for Butte. The following table shows actual permit figures for the 50 cities, and an estimate of the total for the country based on per capita figures for the 50 cities applied against the total urban population of the country. Permit figures were supplied by S. W. Straus & Co. The U. S. Bureau of Labor Statistics shows a total reported by 355 cities of $51,845,694 for January and $40,836,173 for February of this year.

BUILDING PERMITS
(Thousands of Dollars)

	Actual 50 Cities	Estimated Total U.S.
Jan. 1931	$30,767	$110,600
Jan. 1932	$14,282	$51,400
Per Cent Loss......	54	54
Feb. 1931	$34,624	$125,200
Feb. 1932	$12,522	$45,100
Per Cent Loss......	56	
Jan.-Feb. 1931	$65,391	$235,800
Jan.-Feb. 1932	$26,804	$96,500
Per Cent Loss......	57	57



LARGE CONTINUOUS PLATE MILL CONSTRUCTED IN NINE MONTHS

The group of buildings which houses the continuous plate and strip sheet mill of the Inland Steel Co., at Indiana Harbor, Ind., covers an area of 340,000 sq.ft. and incorporates the most modern and highly perfected developments of continuous sheet strip production. Actual foundation work on the buildings was started in April, 1931, and the mill was placed in operation nine months later. The mill comprises ten stands in line and will produce plates from 3/16 to ½ in. in thickness and up to a maximum width of 69 in. For continuous strip the width varies from 24 to 66 in. The mill has a rated capacity of 100 tons per hour on 16-gage material, 48 in. wide.

New York Water Tunnel Contract Under Investigation

THE award of all four sections of the 20-mile New York City aqueduct tunnel No. 2 to Patrick McGovern, Inc., in October, 1928, for a contract price of nearly $43,000,000, is reported to be under investigation by Judge Seabury, counsel to the legislative committee that is checking up on municipal affairs in the city. It is said that bank accounts of the three members of the board of water supply are being examined as a result of allegations of undue favoritism in awarding all contracts to one firm at a higher figure than the sum of the low bids for each section.

Analysis of the bids

The state supreme court upheld the board in the award in answer to a suit brought against the city by the Carleton Co., Inc., and the Del Balso Construction Co. The work was advertised in four sections. Low bidders were: section 224, Carleton Co., Inc., $10,585,630, (McGovern, $11,427,988); section 225, Del Balso Construction Co., $10,629,889, (McGovern, $11,151,905); section 226, Patrick McGovern, Inc., $10,472,785; section 227, Patrick McGovern, Inc., $11,439,890. The call for bids requested each bidder to state any reductions offered if two or more sections were awarded him. The following stipulations accompanied McGovern's bids: if sections 224 and 225 were awarded him, deduct $225,000 from each bid or $450,000 from the total; if sections 226 and 227 were awarded him, also deduct $225,000 from each bid or $450,000 from the total; if all four sections were awarded him, deduct an additional $225,000 from each section bid, or an additional $900,000, totaling a deduction of $1,800,000 from the sum of the four sectional bids.

The lowest possible combination of bids was section 224, Carleton Co.; section 225, Del Balso Co., sections 226 and 227, McGovern; totaling $42,678,194, or $14,373 under McGovern's bid of $42,692,567 for the entire project. The board of water supply declared the Carleton Co. unqualified to handle one section of the tunnel, and as the next low bid for section 224 was $11,260,860, this made McGovern's bid for all four sections low by $660,873. The court upheld the board's action in refusing to consider the Carleton bid.

After the decision by the state supreme court the suit was carried to the appellate division, which upheld the supreme court's ruling, and on March 19, 1929, the court of appeals also upheld the decision.

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First Hetch Hetchy Bonds Sold

The first sale of bonds made by the Hetch Hetchy Bond Purchase Syndicate, organized by all the employees on the Hetch Hetchy system (San Francisco) (*ENR*, March 3, p. 334), netted the workers 95.55 per cent of their regular monthly salaries for the month of February. Bonds with a par value of $206,000 were purchased by the syndicate and sold for $196,831. For the present bonds will be sold each month to meet the payrolls.

New Sewage-Disposal System for Duluth

Authorization has been given by the city council of Duluth, Minn., for the construction of the first units of a sewage-disposal system at an immediate cost of $735,000 and an eventual expenditure of $1,400,000. The ultimate plan calls for trunk sewers and pumping stations bringing all sewage to a single plant at a point in the western section of the city. For the present work, which has the approval of the state board of health, 75 per cent of the sewage will be screened and chlorinated in a 30-min. detention basin with horizontal agitators and discharged into Lake Superior. The remainder will be given tank treatment and chlorination at the site of the ultimate plant and discharged into St. Louis Bay.

The money for the project was made possible by approval and sale of a bond issue more than a year ago. Plans are being made by Alvord, Burdick & Howson, consulting engineers, Chicago, who report their completion March 22 with bids probably taken the last of April.

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Bids Opened for Park Hill Storm Sewer in Denver

Bids on the contract for construction of the Park Hill storm sewer in Denver, Colo., were opened on March 16 and disclosed the low bidder to be Construction Service, Inc., & Associates, a combination formed by pooling the resources of J. Everett Young, of Denver, and the Peter Seerie Co., general contractors, also of Denver. The low bid, $1,079,000, was $245,000 less than the city's estimate. It guarantees use of Colorado materials and Denver workmen on the job. Only three firms reached the final stage of competition, fifteen failing to negotiate satisfactory surety bonds.

The principal detail remaining to be settled is whether payment will be in city bonds or cash. Denver, a self-contained administrative unit, has the right by charter to discharge its financial obligation either way.

Trenching operations, preliminary to laying mains, are scheduled to begin April 1. The work will furnish employment for several hundred men during the nine months estimated to complete the job.

◆

To Correlate Information on Snow Hydrology

An endeavor to obtain a record of all work on the hydrology of snow so far accomplished and of projects and plans now under way is being made by the section of hydrology of the American Geophysical Union. The Union through a questionnaire just mailed by J. E. Church, meteorolgist and chairman of the committee on snow surveys, Reno, Nev., hopes to become a clearing house for all workers in the field in order that increased unity and progress may be attained.

The field is being broadened beyond the narrower limits of the economic aspects of snowfall and runoff to include the evolution of snow from its initial fall until its final emergence at the mouth of the stream. This will also necessarily include rainfall and evaporation studies so far as they have a bearing on the forecasting of streamflow. That the subject may be seen in its broadest aspects it is planned to include all studies made not only in the United States but in other countries as well and also in the polar regions.

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Washington Notes

By Paul Wooton

Washington Correspondent

AMENDMENTS that will be proposed to the flood-control act are gradually being perfected by a subcommittee of the House committee on flood control. To make certain that the government must pay for the land it takes a proposed amendment reads in part as follows: "Just compensation shall be paid by the United States for all property used, taken, damaged or destroyed in the carrying out or execution of the flood-control plan, including all property located within the area of the levees, spillways, floodways, diversion channels, storage basins, dredging, reservoirs and other works and the rights-of-way thereover and the flowage rights thereon." The proposed amendment also specifies that the United States must repay all expenditures by persons, corporations, states or political subdivisions of states to adjust or conform their property to meet the requirements of flood-control works.

Rivers and Harbors Work

Growing apprehension that delay in the passage of the war department appropriation bill may lead to a curtailment of rivers and harbors work is not justified, in the opinion of Representative Ross A. Collins, of Mississippi, chairman of the subcommittee on military appropriations. He believes that the department is alarmed unnecessarily over the situation and that the funds carried in the regular supply bill will be available in ample time.

Army engineers do not feel that there is any particular need for haste in the flood-control appropriation, since it is not possible to do much of the flood-control work during high water stages. By the time the river falls enough to permit resumption of large-scale levee work it is expected that the regular appropriation of $32,000,000 will have become available. The river improvement work, on the other hand, is carried on to best advantage during flood stages, because it is necessary to complete the dikes before the high-water stage passes in order to enable the floods to scour out the channel.

Utilities Get Extension

The Interstate Commerce Commission has postponed for one year from Jan. 1, 1933, the effective date of its order requiring all railroads and telephone companies to introduce a complete system of depreciation accounting on percentage rates to be fixed by the commission. The commission has also granted to the carriers and telephone companies an extension of time from Sept. 1 next to Aug. 1, 1933, in which to prepare and submit percentage estimates of depreciation on various classes of property.

PITTSBURGH POST OFFICE AND FEDERAL BUILDING

One of the largest of the federal government's post office projects is under way in Pittsburgh, where a building 532 ft. long, 190 ft. wide at one end and 140 ft. wide at the other is being erected near the Pennsylvania R.R. station. There will be 2,000 ft. of railroad track in the basement, with large trucking areas in a sub-basement. One of the features of the structural design involves the carrying of the trainloads on the steel frame of the building, some of the through plate-girder "bridges" having a span of as much as 60 ft. Many column transfers occur throughout the structure. The tracks coming in on a curve require a column arrangement that must be changed above the first floor, while another complete rearrangement of columns occurs at the fourth floor, where the character of the building changes. About 15,000 tons of structural steel is involved in the structure. The lower four stories of the basement are to be used by the post office, while the upper stories will be occupied by federal government offices and six court rooms and may in the future be extended to the full length of the building. Architects for the building are Trowbridge & Livingston; consulting engineers on foundations, Moran & Proctor; consulting engineers on superstructure, Weiskopf & Pickworth, and general contractors, Aronberg Fried Co., Inc., all of New York. Booth & Flinn have the contract for the substructure, while the structural steel will be fabricated by the Fort Pitt Bridge Works and will be erected by the John L. Mullen Construction Co., of Pittsburgh.

Engineering School to Hold Vocational Guidance Camp

A camp for vocational or collegiate guidance for boys of preparatory school age is to be held Aug. 13-17 at the Stevens engineering camp in northern New Jersey under the auspices of Stevens Institute of Technology. An attempt will be made at the camp to help boys to decide upon the type of college they wish to attend, also to give those students who are inclined toward engineering work a broad picture of what they may expect to find in engineering and in the allied industries. An effort also is to be made to divert those naturally fitted for the liberal art colleges from following the more natural trend of today toward engineering and science.

As the school for surveying instructions for students from Stevens Institute is to be held in the period just preceding the period set aside for boys from the high schools and preparatory schools, the facilities of the summer school will be used to give the boys instruction in the rudiments of surveying. This will provide field work to break the monotony of continuous lecture courses. Speakers at the lecture courses include prominent men from the large engineering corporations, public utilities, engineering schools and engineering societies, also specialists in personnel work, vocational training and research.

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Work on Dotsero Cutoff Must Begin by June 15

Two months' extension, to June 15, in which to commence construction of the Dotsero cutoff has been granted to the Denver & Rio Grande Western by the Interstate Commerce Commission. The road asked for a year's delay, to April 15, 1932, but minority stockholders of the Denver & Salt Lake Railroad, the Uintah Basin League and the Moffat Tunnel Improvement District contended that construction of the long-delayed project should be undertaken immediately.

COSTS AND CONTRACTS

ENR Index Numbers

Cost			Volume		
March,	**1932**	**157.21**	**Feb.,**	**1932**	**105**
Feb.,	1932	161.82	Jan.,	1932	121
March,	1931	194.51	Feb.,	1931	198
Average,	1931	181.35	Average,	1931	220
Average,	1930	202.85	Average,	1930	260
1913	......	100.00	1913	....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of March 24, with some comparisons, total as follows:

(In Thousands of Dollars)

	Mar. 24,	Average of Last Four Weeks	
Buildings:	1932	1932	1930
Industrial	$1,590	$1,097	$4,141
Other	6,892	6,366	16,553
Streets and roads.	5,466	3,420	13,347
Other construction.	8,241	6,279	29,218
Total	$22,189	$17,163	$62,760

Total, all classes, Jan. 1 to Mar. 24:

1932	$236,170
1931	666,777

LONGEST RAILROAD LIFT SPAN COMPLETED AT BOONVILLE, MO.

The Missouri-Kansas-Texas Railroad Co.'s new bridge crossing the Missouri River at Boonville, Mo., was completed in January and the contractor, the Kansas City Bridge Co., has been engaged in demolishing the adjacent old bridge, the piers of which were built in 1874. Included in the five-span crossing is a 408-ft. lift span weighing 1,150 tons, the longest railroad lift span yet built.

Hoover Dam Notes

Better progress than at any time since the flood early in February was made during the week ended March 12 in the 41x56-ft. enlarged headings in tunnel No. 1 at Hoover Dam. This tunnel is the only one of the four in which the enlarged headings have not been holed through. During the week a total of 335 ft. of 41x56-ft. heading was excavated. Work on the 15-ft. bottom bench was carried on in tunnels No. 2, 3 and 4, a total of 1,545 ft. being taken out during the week. Trimming work covered 980 ft. in these three tunnels. Concreting of the trashrack foundation at the upper portal of tunnel No. 2 was nearly completed.

* * *

Excavation at the Nevada spillway was continued on a two-shift basis. Driving of pioneer tunnels was continued without interruption in the Arizona inclined spillway tunnels, but work in the Nevada tunnel was stopped for two days on account of bad air. At the end of the week the pioneer heading in the Nevada tunnel was 460 ft. from the roof of the diversion tunnel. The Arizona tunnel was 270 ft. from the roof of that tunnel. Excavation of an adit to the pioneer tunnel in the Nevada inclined spillway tunnel was started March 8.

* * *

The total working force on the project March 8 numbered 2,989 men. There was one fatality during the week ended March 12. A mechanic was crushed between two trucks.

Utah Building and Construction Congress Organized

The Utah Building and Construction Congress was formed in Salt Lake City on March 11 with the object of smoothing out the annual curves of construction activities, eliminating seasonal unemployment in the building crafts and stimulating building and construction activities generally in Utah. The congress will also attempt to advance winter construction and intensify public-works activities during periods of depression. Raymond J. Ashton, architect, of Salt Lake City, was elected president and vice-presidents were elected from the several counties. R. A. Hart and George R. Randall, both of Salt Lake City, were chosen secretary and treasurer respectively. Directors were elected to represent various groups as follows: architects, engineers, engineering contractors and subcontractors, craftsmen, clay products, cement and plaster, lumber and mill products, hardware, paint and glass, plumbing and heating, metal products, financial agencies, realtors, building owners and operators, utilities, electrical products, allied products, building contractors and subcontractors.

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State Capitol Planned for North Dakota

Architects' plans for a state Capitol to replace the building at Bismarck, N. D., destroyed by fire in 1930 are under consideration by the state Capitol commission. With present reduced prices it is expected that the building will cost about $2,000,000. The associated architects are Joseph Bell DeRemer, Grand Forks, N. D., W. F. Kurke, Fargo, N. D., and Holabird & Root, Chicago, Ill.

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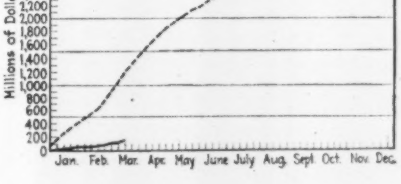
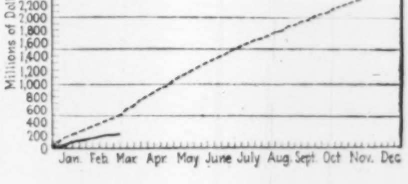
Youngstown, Ohio, to Revamp Its Water-Distribution System

Approval by the city council is expected of the $400,000 expenditure for revamping the water-distribution system of Youngstown, Ohio, proposed by Dan Parrish, water commissioner. The plan involves abandonment of the present pumping station, laying new mains, installation of three new water-storage tanks and four automatic electric booster stations, to provide water in the high-pressure areas.

Capital and Contracts

New capital issued in the week ended March 19 totaled $38,000,000, compared with $20,000,000 in the preceding week and $148,000,000 in the corresponding week of 1931. State and municipal bonds represented $26,000,000, or 68 per cent of the March 19 total. The cumulative total for the period between Jan. 1 and March 19 was $166,000,000, against $1,058,000,000 issued in the corresponding part of 1931.





Exhaustive Geological Study Made of Hoover Dam Site

After an exhaustive geological study of the Hoover Dam site, F. L. Ransome reports "that nothing has been found which calls for any modification of the project as now planned and in process of practical realization."

The rocks in the vicinity of the dam were found to be Tertiary and of younger age. The report says that they are predominantly lava flows but include intrusive rocks. The lavas are associated with sedimentary formations. The volcanic eruptions and the deposition of breccias were found to be contemporaneous and overlapping.

Engineering Departments of Three U. P. Units Consolidated

Consolidation of the engineering departments of the three units of the Union Pacific System, with headquarters in Salt Lake City, has been announced. The three units involved are the Los Angeles & Salt Lake, the Oregon Short Line and the Oregon-Washington Railroad & Navigation Co.

B. H. Prater, chief engineer of the Oregon Short Line, has been named chief engineer for the three units. Employees of the engineering departments at Los Angeles and Portland, Ore., where engineering headquarters were formerly maintained, have been transferred to Salt Lake City.

Los Angeles Postpones Vote on Power Bond Issue

Decision not to place a proposed $34,400,000 power bond issue proposal on the ballot for the May 3 election has been reached by the Los Angeles, Calif., city council. Another date will be chosen, possibly the date of the general election in November. Proceeds of the issue, if voted, are to go toward the construction of a transmission line to Hoover Dam, construction of a steam-generating plant at Wilmington and extensions and betterments to the lines of the bureau of power and light.

Personal Notes

Neil W. McGill, who was appointed director of public utilities of Cleveland, Ohio, to succeed E. H. Krueger, resigned after a week in office and has been succeeded by A. R. Brueggeman.

John W. Baumgartner, civil engineer, has been appointed a member of the water and power commission of Los Angeles, Calif. Confirmation of his appointment by the city council breaks a deadlock in the board that has existed since the resignation of O. T. Johnson, Jr., last summer.

Lawson Scott has been named city engineer of Marietta, Ohio, succeeding Chester Stone, resigned.

Paul A. Hodgson, major, Corps of Engineers, has been asssigned as assistant to the engineer commissioner of the District of Columbia, effective upon completion of his courses at the command and general staff school, Fort Leavenworth, Kan., which will be about July 1.

George G. Neihouse, dean of the engineering school at Tri-State College at Angola, Ind., has been named president of the institution to fill a vacancy caused by resignation. Dean Neihouse has been with the college since 1902, going there from Purdue University.

Elliott Vandevanter, captain, Corps of Engineers, now stationed in Washington, D. C., has been assigned as assistant to Major W. D. Styer, district engineer, in charge of the Pittsburgh district.

Obituary

John J. Moriarty, retired bridge engineer and former member of the San Francisco board of public works, died in San Francisco on March 1, at the age of 74.

Frederick W. Miller, civil engineer, died on March 17 at his home in Babylon, L. I., at the age of 74. Mr. Miller specialized in testing wells in Manhattan and Brooklyn.

Thomas P. Punshon, city engineer of Cincinnati for two terms beginning in 1897, died on March 16 in Miami, Fla., at the age of 75. Mr. Punshon was one of the founders and a former president of the Cincinnati Engineers Club.

Nathan Boris Levinge, building contractor, of Birmingham, Ala., died on March 6 at the age of 66. Mr. Levinge was a native of France, but had been a resident of Birmingham for about twenty years and constructed some of the most prominent public buildings in the city.

B. A. Adams, for several years in the city engineering department of Jacksonville, Fla., died suddenly on March 12. Mr. Adams was born in Richmond, Va., 61 years ago and was graduated from Virginia Polytechnic Institute. At one time he was assistant city engineer of Memphis, Tenn.

George D. Barnes, vice-president of the Syracuse Cinder Products Co., of Syracuse, N. Y., died at his home in that city on March 17. Mr. Barnes was engaged in general contract work for 40 years in Auburn, N. Y., and five years ago went to Syracuse as vice-president of the Cinder Products company.

John T. Clancy, assistant manager of oil and gas engine sales of the Worthington Pump & Machinery Corp., died suddenly of a heart attack on March 9 while lecturing at the Engineers Club, New York City, before a meeting of the American Society of Mechanical Engineers. Mr. Clancy was formerly an instructor in mathematics and chemistry at the Army and Navy School, Washington, D. C., and after serving in the World War joined the Worthington company in 1919.

James Kelly, the oldest employee of the New Brunswick, N. J., water department, died at his home in New Brunswick on March 11, at the age of 87. Mr. Kelly first went to New Brunswick in 1867 in the employ of a company making a specialty of installing a cement-lined water pipe. In 1873, when the city took over the water system, he was engaged by the water department and had been in active service of the city up to two years ago, when he retired.

E. L. Carpenter, federal district civil engineer of Seattle, who was connected with the United States Engineers for 38 years, following two years with the Quartermaster Corps, died in Seattle on March 14. For thirteen years he was resident engineer during the construction of the jetties in the Grays Harbor district. He also superintended the original tideland fill at Olympia, Wash., was connected with the first jetty work at Coos Bay, Ore., and spent six years in Alaska on federal projects at Wrangell Narrows and on the Yukon.

Frank G. Baum, consulting hydro-electric engineer, died in Redding, Calif., March 14 from injuries suffered in an accidental fall from a hotel roof while inspecting newly installed equipment. A graduate of Stanford University in 1898, Mr. Baum joined the engineering staff of the Standard Electric Co. and later that of the California Electric Co. When those two utilities were consolidated to form the Pacific Gas & Electric Co. he was made chief engineer, a position he held until 1907, since which time he had been in private practice as a consulting hydro-electric engineer. He did much work in South America in the development of high-voltage transmission lines at high altitudes and was the inventor of the constant-potential electric transmission system, which made possible nationwide interconnecting power.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July, date to be fixed.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Memphis, Tenn., May 2-6.

AMERICAN WELDING SOCIETY, annual meeting, New York City, April 27-29.

NEW ENGLAND SEWAGE WORKS ASSOCIATION, annual meeting, Boston, April 25.

BOSTON SOCIETY OF CIVIL ENGINEERS at its 84th annual meeting March 16 elected officers as follows: president, Ralph W. Horne; vice-president, Prof. J. B. Babcock, 3d; secretary, Everett N. Hutchins; treasurer, Karl R. Kennison. Honorary membership was conferred upon Dr. Karl T. Compton, president of Massachusetts Institute of Technology, and Charles T. Main, consulting engineer. Annual prizes for noteworthy papers presented at society meetings during the past year were awarded as follows: The Desmond FitzGerald medal to H. K. Fairbanks, engineer of the New England Public Service Corp., Augusta, Maine; prizes of books to J. Stuart Crandall, William M Bassett, J. B. Belknap and C. I. Sterling.

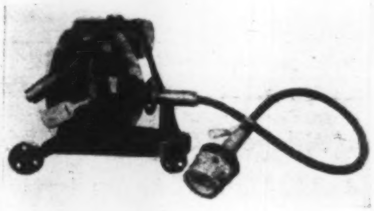
NEW YORK STATE SECTION, American Water Works Association, will meet in annual session in Syracuse April 7-8.

SOUTH CAROLINA SOCIETY OF ENGINEERS and allied organizations will hold a joint convention at Wrightsville Beach, near Wilmington, N. C., July 21-22. The other organizations participating in the meeting will be: North Carolina Society of Engineers; North Carolina Chapter, American Institute of Architects; Carolinas Branch, Associated General Contractors of America; and Plumbing and Heating Contractors' Association.

Construction Equipment and Materials

Concrete Surfacer for Highways

A heavy-duty surfacer designed especially for highway work is an addition to the Berg line of concrete surfacing equipment manufactured by the Concrete Surfacing Machinery Co., Cincinnati, Ohio. The new machine is available in electric motor drive or gas engine power. The electric model is equipped with a 110-220 volt single-phase alternating-current motor, mounted on three wheels. The gas engine model is powered by one 1-hp. air-cooled gas engine, mounted on a specially designed steel chassis. The 7-ft. flexible shaft is standard equipment on both models.



Berg heavy-duty highway surfacer.

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Two Handy Carbide Lights

Two new models of National Carbide V-G lights have been introduced by the National Carbide Sales Corp., Lincoln Bldg., New York City. One of the new models is an enlarged type V-G light which burns twelve hours on a 7-lb. charge of carbide. Seventy-five per cent of the weight of this lamp is on the bottom, so it does not easily tip over. But if it should tip over no harm is done, as the lamp is gas tight and self-contained so there can be no spilling of water or spreading of flame. Another feature of this light is the extra or extension light, which may be attached by 15 ft. of rubber hose and used simultaneously with the regular unit. The V-G handy-light, another new model, is a small unit weighing but 23 lb. and burns nine hours on 2 lb. of carbide. This model uses a lava-tipped burner housed in a reflector hood, similar to that used on trucks.

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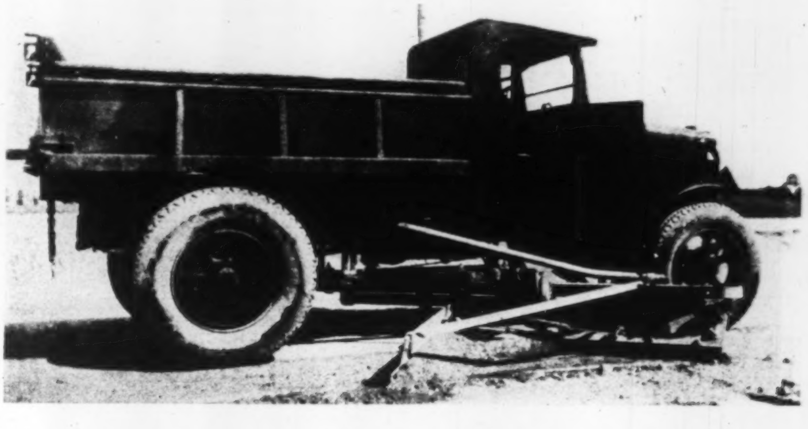
Hydraulic-Operated Scraper for Maintenance and Shoulder Work

Two new hydraulic operated scrapers, one for maintenance and the other for shoulder work, both truck-mounted, have been introduced by the Willett Manufacturing Co., Grand Rapids, Mich. The shoulder scraper extends out on the road shoulder from the right side of the truck, being braced back to the frame of the truck, and has no extension whatever on the left side of the truck. A moldboard-mounted curved cutting blade 4 ft. long cuts out the ruts, the rough spots and grass and weeds on road shoulders and brings all overflow material up flush with the edge of the pavement. Excess material overflowing on the pavement is cleaned up by a rear angling blade, which is held down to the pavement by coiled springs. The rear angling blade, 7 ft. long, not only removes the overflow material from the pavement surface but spreads it evenly over the shoulder in the wake of the cutting blade, forming a smooth shoulder flush with the pavement edge. The shoulder scraper operates efficiently at speeds of 7 to 8 miles per hour.

Willett has also introduced a new model spring scraper for road maintenance work. Scrapers, either 10 or 12 ft. in length, are built in two sections, 5 and 6 ft. long, respectively. Each section has its individual shaft, moldboard and blade and its own hydraulic cylinder, permitting independent control of each blade, if desired. The hydraulic cylinders are operated with either quick-acting hand pumps or heavy Willett electrically driven gear pumps which take power off the truck battery. All controls are in the cab. Efficient operation is secured by running the truck from 10 to 15 miles per hour.

Hydraulic-operated special shoulder scraper.



New Equipment in Brief

Large Scraper Bucket—A "Crescent" scraper of 14-cu.yd. rated capacity has been built by Sauerman Bros., Inc., of Chicago, for use on Mississippi River levee work. This is larger by 2 cu.yd. than the largest previous bucket, and larger by 4 cu.yd. than any bottomless bucket built prior to 1931. The new bucket is 12½ ft. long, 11½ ft. wide and 7 ft. high.

Triplex Sludge Pump—Marlow Pumps, Ridgewood, N. J., has added a new Triplex sludge pump to its existing line of Marlow Simplex and Duplex sludge pumps. The new size pump, of the plunger pattern, is equipped with Hyatt roller bearings, V-belt drive, and inlet and outlet 6-in. flanged connections.

Flexible Metallic Tubing—A seamless, flexible metallic tubing, made of special bronze alloy seamless pipe, corrugated in round-thread single-lead deep wall form and protected with a casing of braided copper, has been placed on the market by the Bendix Aviation Corp., South Bend, Ind. The tubing is designed for use as a fluid connection between moving parts for absorption of vibration and conveyance of liquids, semi-liquids, steam or gas. In tests it has withstood pressures of 10,000 lb. per sq.in. and temperatures of over 500 deg. The hose is being manufactured at present with internal diameters from 3/16 to 1 in.

New Publications

Welded Pipe—Republic electric weld line pipe and casing, its manufacture, characteristics and uses are described in a 36-p. booklet issued by the Republic Steel Corp., Youngstown, Ohio.

Wire Rope—Twelve reasons why you save money with "Lay-Set" preformed wire rope are given in a booklet published by the Hazard Wire Rope Co., Wilkes-Barre, Pa.

Small Power Shovels—Catalog B-1 of Bay City Shovels, Inc., Bay City, Mich., contains specifications, illustrations and details of the new full-revolving ⅜-yd. Bay City shovel.

Monel Metal Bolts—An outline of the properties of Monel metal bolts is given in bulletin P-1 issued by the development and research department of the International Nickel Co., Inc., 67 Wall St., New York, N. Y.

Roller Chains—Engineering data, characteristics and uses of Rex roller chains and sprockets are given in catalog 440 published by the Chain Belt Co., Milwaukee, Wis.

Earth-Moving Equipment—An 8-p. booklet describing the line of "Bodie" earthmoving and roadbuilding equipment has been prepared by the Bodinson Mfg. Co., Inc., 4401 San Bruno St., San Francisco.

Teegrid Floor System—Truscon Steel Co., Youngstown, Ohio, describes the new Truscon teegrid floor system for bridges, sidewalks and heavy-duty floors, in the Truscon Engineering Handbook No. 4. The teegrid system consists of structural tees placed side by side with their flanges welded together and with triangular crossbars pressure-welded into the tops of the stems of the tees. The assembly is filled flush with concrete. The top surface of the crossbars and the stems of the tees form a steel-armored wearing surface. The handbook contains extensive design data for use of teegrid systems as structural floors.

Graphited Oils—A technical bulletin pertaining to the application of colloidal graphite to the industry has been issued by the Atcheson Oildag Co., Port Huron, Mich.

Metal Alloy Steel Products—The 1932 Buyers' Guide for nickel alloy steel products has been published by the International Nickel Co., Inc., 67 Wall St., New York. The guide, a directory of manufacturers, fabricators and distributors, is divided into five sections as follows: section 1, structural grades, 1 to 5 per cent nickel steel; section 2, corrosion-resistant steels; section 3, heat-resistant nickel chrome-iron alloys; section 4, special ferro-nickel alloys; section 5, special services.

Current Construction Unit Prices

Dredging Earth and Rock in Illinois Waterway

CHANNEL 10 ft. deep in rock and earth with bottom width 200 to 300 ft. is being dredged in the Starved Rock Pool of the Illinois waterway from Ottawa to Marseilles Lock, Ill., a distance of 3.6 miles. Materials are gravel, boulders, blue clay and ledge rock. Eleven bids were received on 376,000 cu.yd. of earth and rock and ten alternate bids on 244,000 cu.yd. Averages of all unit prices were given and of the lowest two bidders: (A) Al Johnson Construction Co., 141 Forshay Tower, Minneapolis; (B) Clark Dredging Company, Miami.

Excavation	A	B	Average All Bids
210,000 cu.yd. earth	$0.26	$0.40	$0.72
156,000 cu.yd. rock	1.30	1.78	2.51
Alternate bid			
83,000 cu.yd. earth	0.38	0.50	0.66
161,000 cu.yd. rock	1.30	1.78	2.60

Boiler and Deck Castings

CONRACTS were let in February, 1932, by the U. S. Engineer Office at Duluth for 9,613 lb. of miscellaneous boiler and deck castings for floating equipment. The successful bidders on the various items were: 1, 3, 5, 6, 8, Carl Hartmann, Green Bay, Wis.; 2, Acme Foundry Co., Superior; 7, Clyde Iron Works Sales Co., Duluth. Contract prices are given below:

(1) 150 c.-i. rocker gates, each 42 lb.	$0.02¼
(2) Four c.-i. center support bars, each 175 lb	.049
(3) Two c.-i. corrugated side bars, each 78 lb	.02¼
(4) Six c.-i. filler bars, each 35 lb	.02¼
(5) Two sets c.-i. baffle plates, each 140 lb	.02¼
(6) 1,329 lb. grate bars	.02¼
(7) Seven 18-in. diam. cast-steel deck scuttle rings, each 30 lb	.09¾
(8) Four cast-steel deck scuttle covers, each 68 lb	.14

Sewer in East 82d and 83d Sts., Cleveland

A BRICK sewer 6 to 9½ ft. in diameter and 6,168 ft. long is being constructed in tunnel in East 82d St. and East 83d St. from Euclid Ave. to Buckeye Rd., Cleveland. The five items listed below total 91 per cent of the contract price. Eight bids were received averaging $464,000, and the principal unit prices are given of the lowest three bidders: (A) A. L. Connelly Co., 1900 Euclid Bldg., contract, $419,973; (B) Carroccio & Gandio, $420,166; (C) Joseph Winterbottom Co., $444,960.

Circular Brick Sewer	A	B	C	Amount
1,016 ft. 9½-ft	$69.75	$85.00	$79.50	$70.866
370 ft. 9-ft	68.50	63.00	74.40	25.345
2,478 ft. 8½-ft	64.00	60.00	71.63	158.592
1,777 ft. 7¾-ft	59.00	55.00	61.10	104.843
527 ft. 6-ft	43.00	35.00	45.12	22.661
No. calendar days	120	150	330	289

Sewer and Drainage on Arsenal Island, Ill.

COMBINED storm and sanitary sewer systems on Arsenal Island in the Mississippi River opposite Rock Island, Ill., is being constructed in place of an existing system affected by the construction of lock and dam No. 15. Contract was let in September, 1931, by the U. S. Engineer Office at Rock Island to the McCarthy Improvement Co., Davenport, for $72,133.

The principal items are excavation at $10,910 and 36- to 48-in. concrete pipe at $31,941, the two amounting to 87 per cent of the contract price. Common excavation price includes placing earth as bedding for the sewer laid in rock and for backfilling. Rock includes disposal within 3,000 ft. of excavation. Depth of sewer averages 14 ft. for the 48-in., 10 ft. for the 42-in. and 8 ft. for the 36-in.

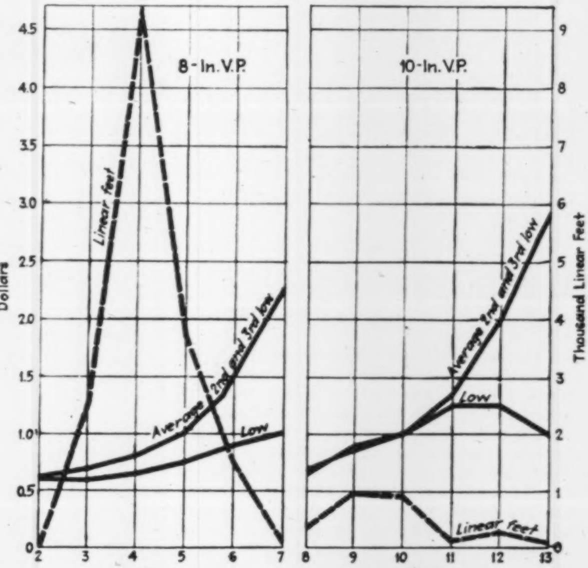
Bids were received from 33 contractors, and unit pric of the principal items are given of the lowest three bidder (A) McCarthy Improvement Co., Davenport, Iowa, con tract; (B) W. B. Carter, Sioux City, Iowa; (C) Litti Construction Co., Davenport. Major Glen E. Edgerton i district engineer.

	A	B	C
8,064 cu.yd. common excav	$0.70	$0.77	$0.6
11,537 cu.yd. rock excav	2.19	2.80	2.1
2,837 lin.ft. 48-in. reinf.-con. pipe	5.25	4.80	5.5
2,140 lin.ft. 42-in. reinf.-con. pipe	4.45	4.00	4.60
2,090 lin.ft. 36-in. reinf.-con. pipe	3.60	3.10	3.8
518 lin.ft. 18-in. vit. clay pipe	1.40	1.16	1.70
630 lin.ft. 12-in. vit. clay pipe	.57	.76	1.00
3,000 lin.ft. 8-in. clay drain	.51	.47	.7
1,240 lin.ft. 6-in. clay drain	.42	.35	.7
Total	$72,133	$74,882	$75,840

Sewer System for Village of Camillus, N. Y.

BIDS were received Feb. 11, 1932, by the board of trustees of the village of Camillus, N. Y., for a system of sewers and a sewage-disposal plant to cost $41,481. About 40 per cent of the cost is for 17,134 ft. of 8-in. and 2,709 ft. of 10-in. vitrified pipe, and unit prices are given of the lowest three bidders: (A) Paul Vellano, Schenectady; (B) C. T. Hookaway, Syracuse; (C) Mondo Construction Co., Syracuse. These prices and the footage for each item are charted herewith. Henry C. Allen and Alfred R. Holmes, Syracuse, are engineers.

Vitrified Pipe	A	B	C
1. 260 ft. 6-in., 4-8 ft. deep	$0.50	$0.70	$0.90
2. 20 ft. 8-in. under 4 ft	.60	.75	.50
3. 2,495 ft. 8-in., 4-6 ft	.60	.80	.60
4. 9,353 ft. 8-in., 6-8 ft	.65	.85	.75
5. 3,720 ft. 8-in., 8-10 ft	.75	.90	1.10
6. 1,446 ft. 8-in., 10-12 ft	.90	1.25	1.50
7. 100 ft. 8-in., 12-14 ft	1.00	2.00	2.50
8. 350 ft. 10-in., under 4 ft	.65	.75	.60
9. 984 ft. 10-in., 4-6 ft	.90	1.00	.75
10. 935 ft. 10-in., 6-8 ft	1.00	1.10	.90
11. 100 ft. 10-in., 8-10 ft	1.25	1.20	1.50
12. 240 ft. 10-in., 10-12 ft	1.25	2.00	2.00
13. 100 ft. 10-in.. 12-14 ft	1.00	2.75	3.00
14. 60 ou.yd. 1:3. 3:6 conc	10.00	12.00	10.00
	$41,480.45	$45,597.55	$46,612.25



Low bids on the 20,000 ft. of 8- and 10-in. vitrified pipe for Camillus sewers.